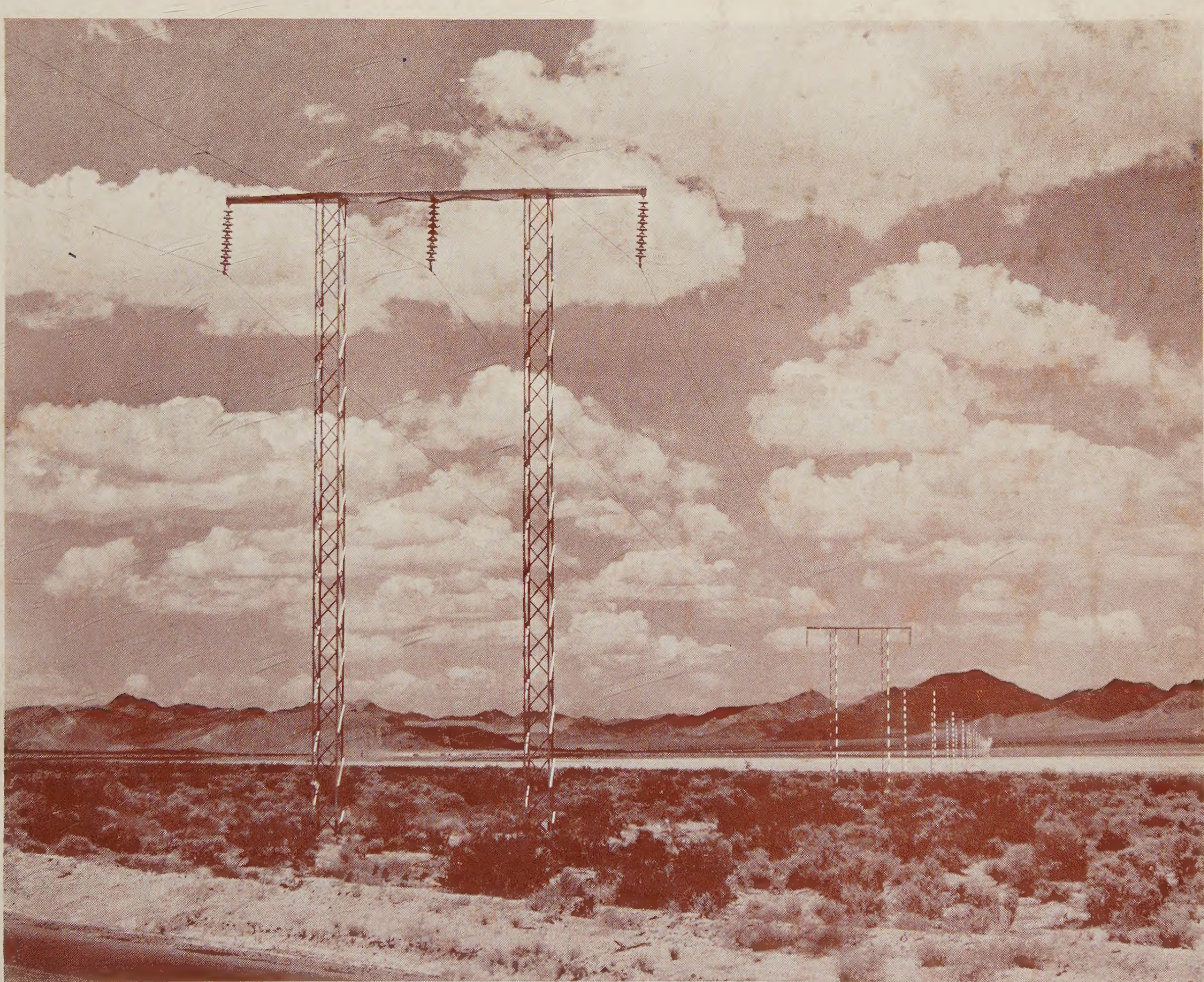
Electrical Engineering

September
1931



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FUTURE MEETINGS

of the

American Institute of Electrical Engineers

Place	*Dates*	*Nature*	*Latest Date for Receipt of Manuscripts*
Kansas City, Mo.	Oct. 22-24, 1931	District Meeting	(Closed)
New York, N. Y.	Jan. 25-29, 1932	Winter Convention	Oct. 26, 1931
Milwaukee, Wis.	March 14-16, 1932	District Meeting	Dec. 14, 1931
Providence, R. I.	May - 1932	District Meeting	Feb. - 1932
Cleveland, Ohio	June 20-24, 1932	Summer Convention	March 20, 1932

NOTE: Members who are contemplating submitting papers for presentation at any of the above meetings should communicate promptly with Institute headquarters, 33 West 39th Street, New York, N. Y., so that their papers may be docketed for consideration by the Meetings and Papers Committee, as programs for all meetings are formulated several months in advance. Upon receipt of this notification, Institute headquarters will mail to each prospective author information in regard to the Institute's rules relating to the preparation of manuscript and illustrations.

MEETINGS OF OTHER SOCIETIES

INTERNATIONAL ILLUMINATION CONGRESS 1931, London, Glasgow, Edinburgh, Sheffield and Buxton, Birmingham, and Cambridge, September 1-19, 1931. (Honorary General Secretary, International Illumination Congress, 32 Victoria Street, London, S. W. I., England.)

SOUTHWEST POWER CONFERENCE, Kansas City, September 7-11, 1931. (A. L. Maillard, 1330 Grand Ave., Kansas City, Mo.)

PENNSYLVANIA ELECTRIC ASSOCIATION, Bedford Springs Hotel, Bedford Springs, Pa., September 9-11, 1931. (H. A. Buch, Telephone Bldg., Harrisburg, Pa.)

THE AMERICAN PHYSICAL SOCIETY, Schenectady, N. Y., September 10-12, 1931. (W. P. Jesse, Research Laboratory, General Electric Co.)

EMPIRE STATE GAS AND ELECTRIC ASSOCIATION, The Sagamore, Bolton Landing, Lake George, N. Y., September 10-11, 1931. (C. H. Chapin, Grand Central Terminal, New York, N. Y.)

INTERNATIONAL ASSOCIATION OF ELECTRICAL INSPECTORS, Eastern and Western Sections (joint meeting), Pittsburgh, Pa., September 14-17, 1931. (R. W. E. Moore, National Electric Mfrs. Assn., 420 Lexington Ave., New York, N. Y.)

AMERICAN WELDING SOCIETY, Copley-Plaza Hotel, Boston, Mass., September 21-25, 1931. (M. M. Kelly, 33 West Thirty-Ninth Street, New York, N. Y.)

NATIONAL ELECTRIC LIGHT ASSOCIATION: New England Division, Poland Springs House, South Poland, Me., September 28-30, 1931 (Miss O. A. Bursiel, 20 Providence St., Boston); Great Lakes Division, French Lick Springs Hotel, French Lick, Ind., October 1-3, 1931. (T. C. Polk, 20 North Wacker Drive, Chicago, Ill.)

ASSOCIATION OF ELECTRAGISTS INTERNATIONAL, Hot Springs, Ark., October 5-8, 1931. (L. W. Davis, 420 Lexington Avenue, New York, N. Y.)

NATIONAL SAFETY COUNCIL, Stevens Hotel, Chicago, Ill., October 12-16, 1931. (W. H. Cameron, managing director, 20. North Wacker Drive, Chicago, Ill.)

ILLUMINATING ENGINEERING SOCIETY, William Penn Hotel, Pittsburgh, Pa., October 13-16, 1931. (E. H. Hobbie, 29 West Thirty-Ninth Street, New York, N. Y.)

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This Month—

Front Cover

New 132-kv. line connecting Hoover Dam with The Southern Sierras Power Company at San Bernardino (Calif.) 225 mi. distant. The Nevada-California state line runs through the white strip of desert sand in the central background.

—Photo by Avery E. Field, Riverside, Calif.

—— Turn to Next Page

KANSAS CITY meeting of the A. I. E. E. South West District offers a program of attractive technical subjects, good entertainment, and profitable inspection trips. (*See pp. 757-9.*)

TO GIVE a timely résumé of technical papers presented at the recent Pacific Coast convention and also to provide opportunity for ordering copies without further delay, abstracts of these papers not already treated in ELECTRICAL ENGINEERING are included in this issue. (*See pp. 753-6.*)

POWER engineers, particularly those engaged in load-scheduling activities, may be interested in an analysis and comparison of different methods of generating station loading. (*See pp. 722-27.*)

AN EXECUTIVE of one of the leading electrical manufacturing companies gives his conception of "Industry's New Responsibilities," as related to the present business depression. (*See pp. 719-21.*)

NEW institute officers and committees for 1931-32 recently have been announced. (*See pp. 771-6.*)

JUDGING from the letters received, the Engineering Foundation series, "Has Man Benefited by Engineering Progress," has aroused considerable interest among the readers of ELECTRICAL ENGINEERING. (*See pp. 766-7.*) The second article of this group predicts further decentralization of industry. (*See p. 741.*)

A FURTHER example of ELECTRICAL ENGINEERING's policy of reflecting the effects of engineering upon human relationships may be found in a discussion on "The Engineer in Civic Affairs." (*See pp. 727-30.*) Correspondence is invited upon any phase of this all-important subject.

A PORTION of the forthcoming Faraday centennial to be held in London will be rebroadcast over the National Broadcasting Company's network. (*See p. 760.*)

The Mokelumne Hydroelectric Project

California's latest hydroelectric development activities are centered in the Mokelumne River property of the Pacific Gas and Electric Company. This project involves the complete redevelopment of the river, from water surveys to power distribution, and will make available a billion kilowatt-hours annually, ten times the output of a 1902 development on the same stream.

By
E. A. CRELLIN
Fellow A. I. E. E.

Pacific Gas and Electric Company, San Francisco

NOT OFTEN does an addition of generating equipment to an operating system involve all of the features of a complete power system, from the study of water storage and usage, all the way through generation and transmission to the step-down substations. It is this aspect of the Mokelumne River development of the Pacific Gas and Electric Company (Calif.) which seems to make it of more than passing interest. Hydroelectric features are treated in this article; a companion article (see pp. 713-718) discusses the transmission and distribution problems.

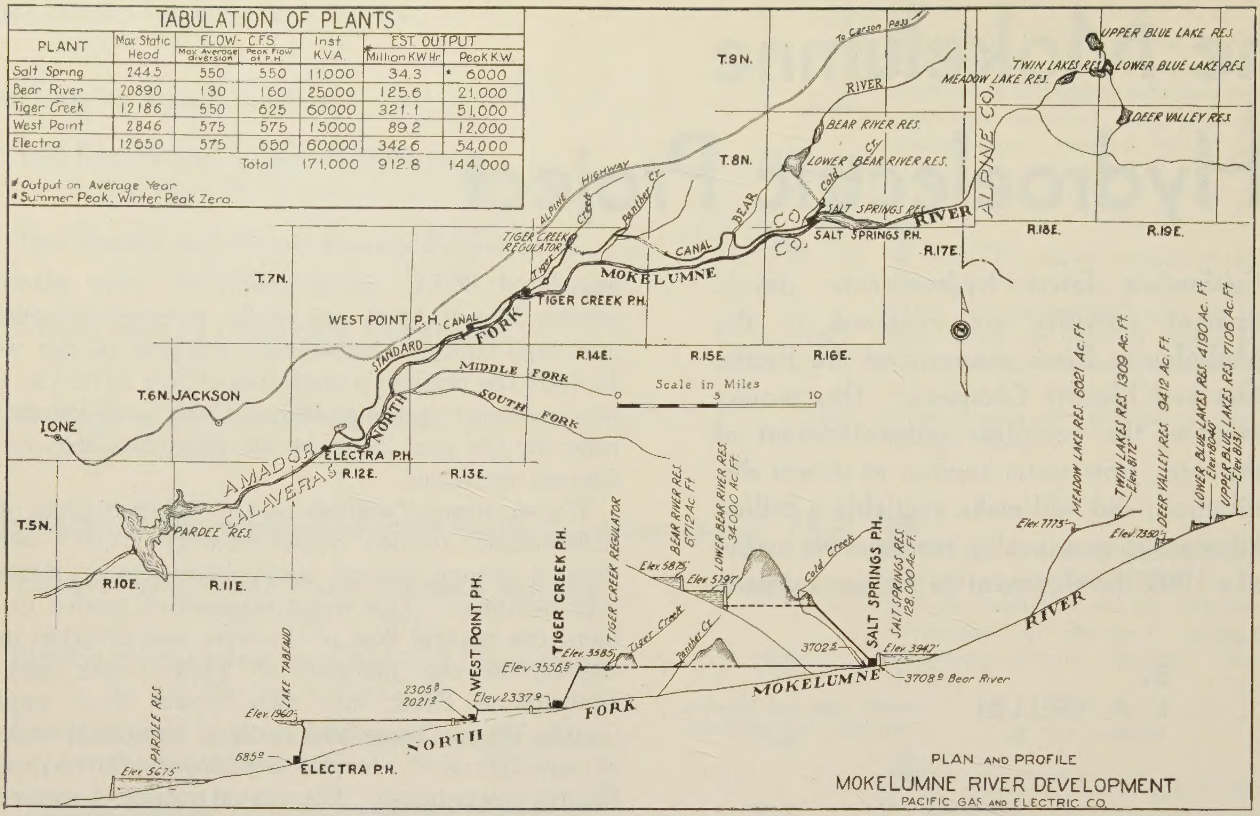
The Mokelumne River is one of the pioneer power streams of California. Its source is in Alpine County approximately 20 mi. south of Lake Tahoe at El. 9,700 whence it flows in a general southwesterly direction for some 120 mi. to a point where its waters join the San Joaquin River on their way to the Pacific Ocean through San Francisco Bay. The lower 60 mi. of the river is quite flat, lying at an elevation of less than 200 ft. above sea level.

The discovery of gold and its accompanying need for water for mining operations brought about the first developments on the Mokelumne River in the fall of 1857. A company formed in that year, and its successors continued in the water supply business until the properties were acquired by the Standard Electric Company of California in the late nineties for the purpose of generating power for transmission to San Francisco, 110 mi. away. Electra power house and its associated 60-kv. transmission line were placed in service May 6, 1902, one of the pioneer hydroelectric and high-voltage transmission projects of the world. In 1907 the original installation of five 2,000-kw. units was increased by the addition of two 5,000-kw. generators; for the past 29 years the plant has been in continuous operation.

Water storage facilities on the upper reaches of the Mokelumne totaled approximately 25,000 acre-ft. divided among several small reservoirs at relatively high altitudes. This water released as needed to augment the natural flow of the river was diverted in the vicinity of the junction of Tiger Creek and the Mokelumne River into two canals (each approximately 20 mi. long and with a combined capacity of some 200 sec-ft.) for delivery into the forebays above Electra power house. The annual output of power from the system was approximately 100,000,000 kw-hr. The foregoing introductory remarks are intended to

Looking down upon Salt Springs power house from the crest of Salt Springs dam. Part of main quarry floor may be seen in right of background

From "The Mokelumne River Development of the Pacific Gas and Electric Company," (No. 31-130) presented at the A. I. E. E. Pacific Coast convention, Lake Tahoe, California, Aug. 25-28, 1931.



TABULATION OF PLANTS

PLANT	Max Static Head	FLOW- C.F.S. Max Average diversion	FLOW- C.F.S. Peak Flow at P.H.	Inst. K.V.A.	EST. OUTPUT *Million KW Hr	EST. OUTPUT Peak K.W.
Salt Spring	244.5	550	550	11,000	34.3	* 6000
Bear River	20890	130	160	25000	125.6	21,000
Tiger Creek	12186	550	625	60000	321.1	51,000
West Point	2846	575	575	15000	89.2	12,000
Electra	12650	575	650	60000	342.6	54,000
			Total	171,000	912.8	144,000

*Output on Average Year
*Summer Peak. Winter Peak Zero.

Plan and profile of Mokelumne River Development of the Pacific Gas and Electric Company (Calif.)

disclose the conditions existing at the time studies for the development of additional power on the Mokelumne River were begun.

Water Supply Development

The upper portion of the Mokelumne River was relatively inaccessible and as a result, actual water record data for the upper portion of the water shed were not available. From 1906 to the present time, complete records of stream flow have been kept of readings taken at gaging stations located near the diversion into the conduits supplying water to Electra power house; and beginning with the early spring of 1924, additional gaging stations were installed at strategic locations on the upper river and certain tributary streams. The information obtained from these later stations was studied in connection with the long-time record of the original stations and runoff and storage possibilities were analyzed for 24 consecutive seasons. Runoff characteristics for the upper and lower portions of the river vary during the different months of the year. During the winter and early spring precipitation on most of the upper basin is in the form snow, while that on the lower portion of the development is rain. From the extensive water supply studies and accurate topographic maps it was possible to determine the most advantageous storage sites and to plan a comprehensive development for the most economical utilization of the water. A tabulation was prepared to show the probable use of storage water in maintaining a more or less uniformly regulated flow at the forebays of the various plants. Calculations of energy output showed that the average year would yield approximately 913,000,000 kw-hr., with 1,038,000,000 for a year of full supply and 489,000,000 for the dry-year period.

Consideration was given to the necessity of having peak output sufficient to meet system load conditions at all times, it being assumed that for dry years the peaks would be met by hydro power with steam power carrying the base load. Economic studies showed that the Mokelumne River development required back-up steam capacity of about 35 per cent of the peak, the hydro capacity representing 65 per cent of the peak. Likewise consideration was given to providing for the maximum release of stored water during the summer months (for the benefit of irrigation interests on the lower reaches of the river) which was consistent with maintaining peak demand throughout the late fall and winter. When the project is entirely completed it will involve a total water storage of some 200,000 acre-ft. and the generation of 1,000,000,000 kw-hr. annually, a tenfold increase over the original Electra development.

Two major storage reservoirs, the one on the Mokelumne River known as Salt Springs reservoir, the other on one of the principal upper tributaries and known as lower Bear River reservoir, will impound the runoff waters from their respective drainage areas. The regulation of flow in the Mokelumne River made

possible by these two storage reservoirs together with the smaller reservoirs already in service, is the principal factor contributing to the increased power output. The spillway at Salt Springs dam is at El. 3,947; that of the Bear River dam at El. 5,816. The center-line elevation of the nozzles of the waterwheel units to be installed in the proposed rebuilding of Electra power house is at El. 685. Thus there is provided a total gross head of 3,262 ft. and 5,131 ft. respectively from the two main sources of storage, which head will be utilized in four steps by four power houses.

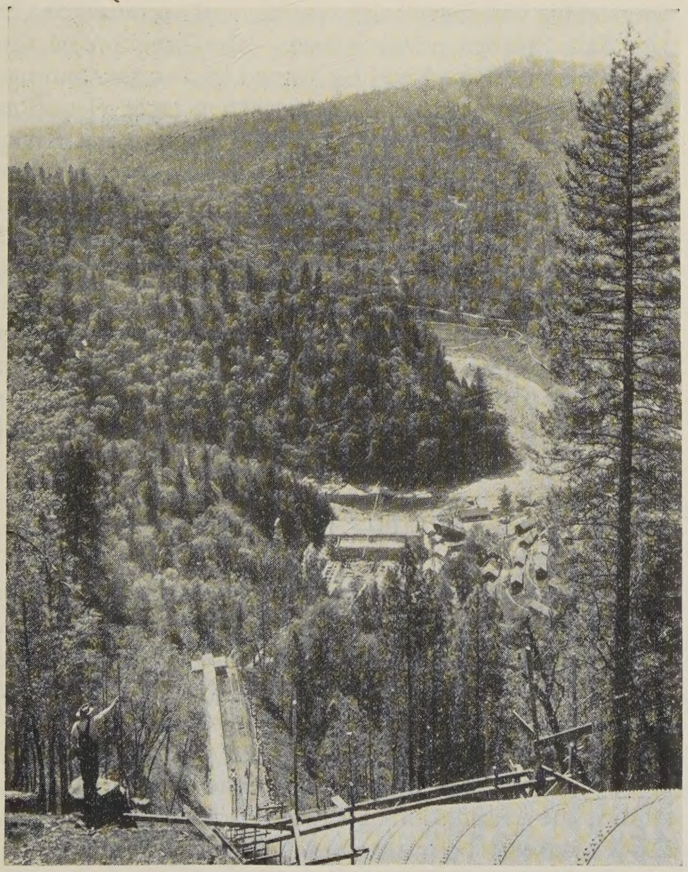
Salt Springs Dam

The rock-fill dam chosen for the major Mokelumne development is believed to be one of the safest kinds of dam that can be built. (This type of dam has been very successful in California.) The canyon which is of solid granite made available at the dam site ample material for its construction. The inaccessible nature of the location necessitated the construction of approximately 50 mi. of roadway suitable for heavy trucking, and required the hauling of all materials involved over this entire distance by motor transport. The high cost of concrete materials at such a site made the estimated cost of a rock-fill dam approximately $2,000,000 less than would have been the case for a suitable concrete dam. Modern large-scale construction equipment was used on the job, including electrically operated shovels to load the rock cars and storage-battery locomotives to haul them.

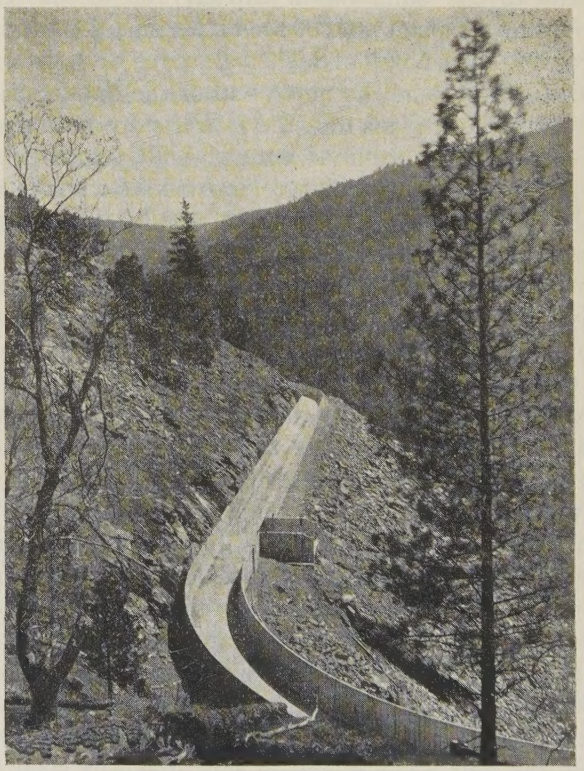
Rock for the dam was obtained from quarries at different levels near the north abutment of the dam and from the spillway excavation on the south bank. The usual quarrying methods followed featured several "big shots," each of which required in excess of 50 tons of powder and brought down approximately 200,000 cu. yd. of granite.

The dam rises 328 ft. above the stream bed, has a crest length of 1,300 ft., is 900 ft. thick at the base, and contains approximately 3,000,000 cu. yd. of material. Approximately 225,000 cu. yd. of rock were derrick-placed to a uniform thickness of 15 ft. over the entire upstream face of the dam. This placed rock forms a foundation for an outer facing of reinforced concrete which covers the entire upstream slope, varying in thickness from 36 in. at the bottom to 12 in. at the top. Concrete was placed in continuously poured 60 x 60 ft. panels of heavily reinforced concrete, each completely isolated from its neighbors by expansion or contraction joints fitted with copper water seals. The horizontal joints were poured concrete-to-concrete except for a coating of asphaltic material; vertical joints were provided with a 1-in. spacing which was filled with asphaltic compounds to permit lateral movement.

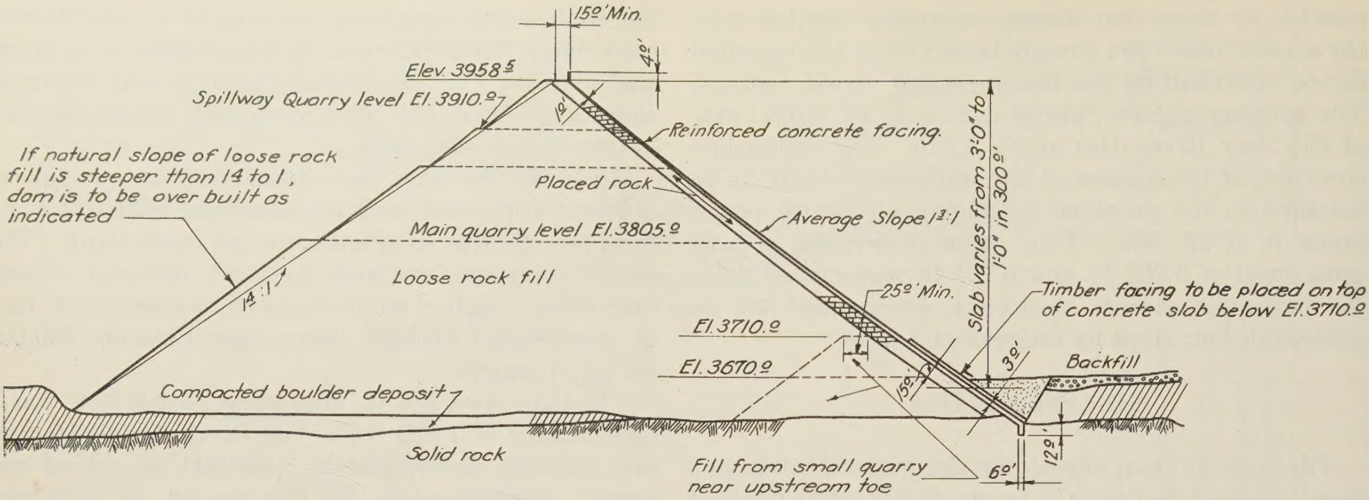
To compensate for probable settling the crest of the dam was crowned to a maximum of from 6 to 7 ft. above the theoretical crest line. To take care of down-



Looking down the penstock toward Tiger Creek power house. The transmission line right-of-way may be discerned on the mountains opposite



A typical section of concrete flume



Maximum cross-section of Salt Springs dam

stream settling resulting from reservoir water pressure the upstream face was designed and constructed with an upstream convexity in plan. For similar reasons and to prevent possible buckling of the concrete face, the face was concave to the water surface in vertical section. The facing contains about 30,000 cu. yd. of concrete, has an area of about 9.2 acres, and is anchored to concrete cut-off walls extending vertically from 5 to 25 ft. into solid granite. Grout holes extend some 50 ft. below the bottom of the cut-off wall.

Salt Springs reservoir has a capacity of 130,000 acre-ft., is 4 mi. long, has a maximum width of 0.75 mi. and floods 925 acres. A spillway with a crest length of 625 ft., channeled in the south side of the gorge adjacent to the dam, has a capacity of 48,000 sec-ft., providing a capacity of 300 sec-ft. per sq. mi. of drainage area with a freeboard of 8 ft.

Outlet works at the north end of the dam consist of two 10-ft. steel pipes inserted into the downstream end of a 19-ft. concrete-lined tunnel, built originally as a diversion tunnel to facilitate construction of the dam. Each pipe is provided with a 129-in. hydraulically operated butterfly valve and then is extended on into the river channel where it ends in a 78-in. butterfly valve designed for free discharge. These valves are provided to permit unwatering the reservoir at the rate of approximately 10,000 acre-ft. per day in case of emergency, and are designed for a maximum head of 275 ft., making them the highest-head free-discharge butterfly valves yet installed.

A branch from one of these pipes forms the 8-ft. penstock to the generating unit installed in Salt Springs power house a few hundred feet downstream from the dam. A branch from the other pipe ends in a 54-in. needle valve in which is incorporated an energy absorber of the through-baffle type which discharges into the power house tailrace forming a bypass to supply water to the Tiger Creek conduit, (which heads in the tailrace) when the Salt Springs unit is shut down or when it is operating under reduced head.

Bear River Water Supply

Bear River, one of the principal tributaries of the Mokelumne River, falls at a very rapid rate from a drainage basin high in elevation, the fall in the last 6 mi. above its junction with the Mokelumne being more than 2,500 ft. A projected 200-ft. dam will form a new Bear River reservoir, adding 34,000 acre-ft. to the storage capacity. Through a tunnel approximately 2.5 mi. in length this will serve a generating unit to be placed in the Salt Springs power house. The junction of the penstock and tunnel will be formed in a surge chamber to be excavated in solid rock, with a crest elevation above high water in the projected lower Bear River reservoir just mentioned. This will permit the water from Cold Creek, (a stream adjacent and similar to Bear River but lacking in storage sites) to be diverted through this surge chamber to serve either the Salt Springs unit or for storage in the lower Bear River reservoir. Any spill from these sources may be stored in Salt Springs reservoir. The arrangement is ideal from the standpoint of ease in using the runoff from the different sources and insures complete conservation of all water resources for maximum usage.

Salt Springs Power House

Salt Springs power house will be unique in that its two generating units will be radically different in design. Two sources of water are available to this plant: the water released from storage in Salt Springs dam under a static head of 244.5 ft., and water released from storage in lower Bear River reservoir under a static head of 2,089 ft. In the first case the head and water quantities require the installation of a Francis-type turbine, while the latter can be utilized only through an impulse wheel. In general, a vertical turbine with its draft-tube setting requires a power-house floor level considerably higher above tail-water elevation than is desirable with an impulse-wheel installation; hence, to maintain the

power house floor on a single level, the cooperation of the turbine builder was sought in the final designs and the unit was constructed to permit its setting at an elevation which also would accommodate the impulse wheel. Although the high-head unit will be installed at a future date considerable progress in the preliminary design of the impulse-wheel unit was required to determine with some degree of accuracy what its probable dimensions would be. This also required cooperation with the waterwheel builders. Preliminary designs were all based on the desire to secure a plant which would make for convenience in operation.

The Francis-type turbine is a vertical-shaft unit designed to pass 550 sec-ft. at heads as low as 175 ft. in order to accommodate the lowered level of water behind the dam as storage is withdrawn. In effect, to maintain full load on the generator this requires a turbine which must be operated at part gate under maximum head conditions and with gate openings increasing as the head falls. At heads less than 175 ft., water will be bypassed around the turbine into the tailrace to maintain the conduit flow at full capacity. The turbine is rated at 13,500 hp., 300 r. p. m., and drives a vertical-shaft waterwheel generator rated at 11,000 kva., 11 kv., 60 cycle, 0.85 power factor. The generator is mounted on a concrete pedestal above the turbine and is totally enclosed with surface air coolers arranged at four points around its circumference. Contrasted to this will be the horizontal shaft unit installed to utilize the water from Bear River, an overhung impulse unit capable of developing approximately 35,000 hp. at 300 r. p. m. to drive a generator having a probable rating of 30,000 kva., 11 kv., 60 cycles, 0.85 power factor.

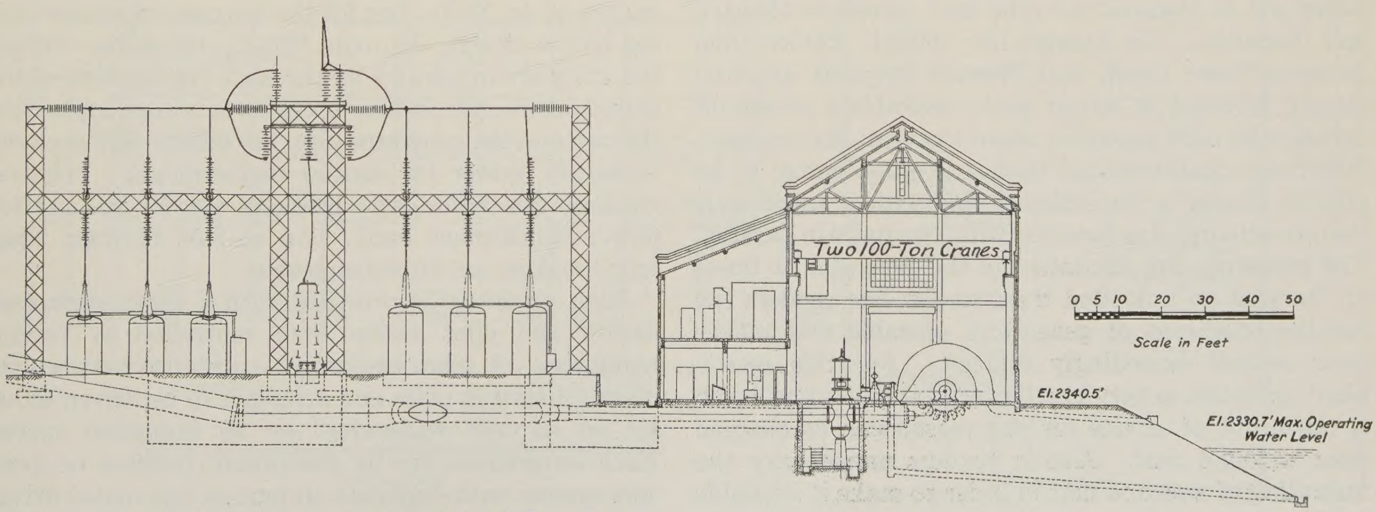
Both units will discharge into the same tailrace which forms the intake for the conduit supplying water to Tiger Creek power house. The capacity of the Tiger Creek conduit is 550 sec-ft. and it is desired to maintain this flow practically constant to supply water to Tiger Creek power house downstream. At full load the Salt Springs turbine unit will pass 550 sec-ft. and deliver power up to the 11,000-kva. rating of its generator, while the impulse unit will pass approximately 180 sec-ft. and deliver power up to the full rating of its generator, about 30,000 kva. Thus it is seen that by properly adjusting the load between the two generating units in the plant it will be possible to maintain a constant flow in the conduit at plant outputs which will vary between the limits of 11,000 kva., or less, and 37,500 kva.

At Salt Springs each generator is connected to a main bus through a single truck-type oil circuit breaker. Two similar breakers, so arranged as to be interchangeable with the main generator breakers, feed power from the main bus into the station power transformer bank. The added cost of the extra large breakers thus required for the service demands was greatly offset by the simplicity of the arrangement and the possibility of taking any oil circuit breaker out of service for inspection or repairs without any loss in plant output. From the main 11-kv. bus, leads run direct to a bank of three 12,000-kva., 11/110-kv. water-cooled transformers. A spare transformer may be substituted for any unit in the bank by means of air-break selector switches. Output from bank is fed through a 115-kv. oil circuit breaker into a single-circuit steel tower transmission line for delivery to the main 220-kv. transformer banks at Tiger Creek power house.

Tiger Creek Conduit

The 17.3-mi. Tiger Creek Conduit terminates in a regulating reservoir on Tiger Creek from which a 625-sec-ft. conduit extends 2.6 mi. to a 40-acre-ft. forebay at the head of the Tiger Creek penstock. The conduit is composed chiefly of a reinforced concrete flume with a water section of 84 sq. ft. and a water depth of 6 ft. In addition to the flume there are two 93-in. steel siphons totaling 0.23 mi. in length, and 2.5 mi. of 10 x 11.3-ft. unlined tunnel.

Topography in the vicinity of the site chosen for



Section through Tiger Creek power house parallel to penstock

the Tiger Creek power house did not offer any suitable location for a forebay of sufficient capacity for the regulation of flow in the conduit and the carrying of peaks of short duration. Accordingly, a compromise was made by the creation of a pond known as the Tiger Creek regulator, about 2.6 mi. upstream from the forebay site, formed by a buttressed-slab concrete dam approximately 100 ft. high on Tiger Creek. The upper 18 ft. of the reservoir thus formed provides a storage capacity of about 175 acre-ft., sufficient to permit peaking Tiger Creek plant for 20 hr. each day when full diversion is being made into the head of the Tiger Creek conduit. About 30 min. are required for water released at the regulator to reach the forebay, and the available capacity in the forebay is sufficient to provide peaking during this interval.

Automatic gates at the outlet of the regulator reservoir maintain a constant flow in the conduit regardless of the height of water behind the gates discharging into the canal. Leads from the float controls have been carried to the switchboard room in Tiger Creek power house, enabling the operator to maintain any desired rate of flow between the regulator and forebay. The design of this automatic gate control equipment was perfected several years ago in connection with the control of water discharged from the afterbay at Pit River No. 3 power house where it has performed in every respect exactly as planned.

Tiger Creek Power House

The penstock consists of a single 4,750-ft. steel pipe varying in diameter from 102 in. at the top to 72 in. at the Y outside the power house. About 4,000 ft. of the upper portion of the pipe is of riveted steel with rivets countersunk on the inside of the pipe; the lower portion is seamless. At the Y the pipe branches into two 52-in. lines and again into four 36-in. lines to serve the four impulse wheels of the two double-overhung units.

Tiger Creek power house is the controlling station for the 220-kv. transmission lines constructed to receive the power generated by the waters of the Mokelumne River and to transmit it to the load centers at Newark and Herndon. To charge the 109-mi. 220-kv. line between Tiger Creek and Newark requires approximately 25,000 kva. which made desirable a minimum capacity for each generator of not less than that amount. Experience has indicated that it is much better to be able to charge a transmission line with a single unit than to attempt this function with two units in parallel. The extremely low excitation of the generator at times of charging an unloaded transmission line renders the parallel operation of generators unstable and makes their control exceedingly difficult. For this reason plant operation is very greatly facilitated if a line which is taken out of service for any reason can be charged from a single unit. Also it renders unnecessary the unloading of a second unit in order to make it available for line-charging purposes.

Static head and water quantities available at Tiger Creek indicated that the plant should have approximately 60,000 kva. in generator capacity, indicating at once that a two-unit layout was the proper one. Each waterwheel unit was designed to deliver 36,000 hp. at 225 r. p. m. under a net effective head of 1,190 ft. Generators are rated 30,000 kva., 11 kv., 60 cycles, 0.85 power factor. These waterwheel units are well up towards the maximum size practical for the head and water quantities available at Tiger Creek and in physical dimensions rank among the largest impulse wheels ever constructed.

Many refinements have been incorporated in the design of the wheels. A straight-flow needle nozzle has been designed introducing into the water flow a minimum disturbance, thus giving a uniform, compact jet delivering maximum power to the waterwheel buckets. The power needles are operated by the governor servomotors and, as a water conservation measure, are arranged for slow closure upon load rejection in much the same manner that the relief valve closes on a large hydraulic turbine installation. Linked with the governor and needle-operating mechanism is a jet deflector in the form of a collar surrounding the jet which operates to remove water from the wheel instantly upon load rejection. The combination of jet deflector and slow-closing needle is ideal for an impulse-wheel installation in that it makes possible the quick diversion of water from the wheel without disturbing the flow in the penstock with its attendant surge. This permits economies in the installation through reduced penstock cost and the omission of a surge chamber.

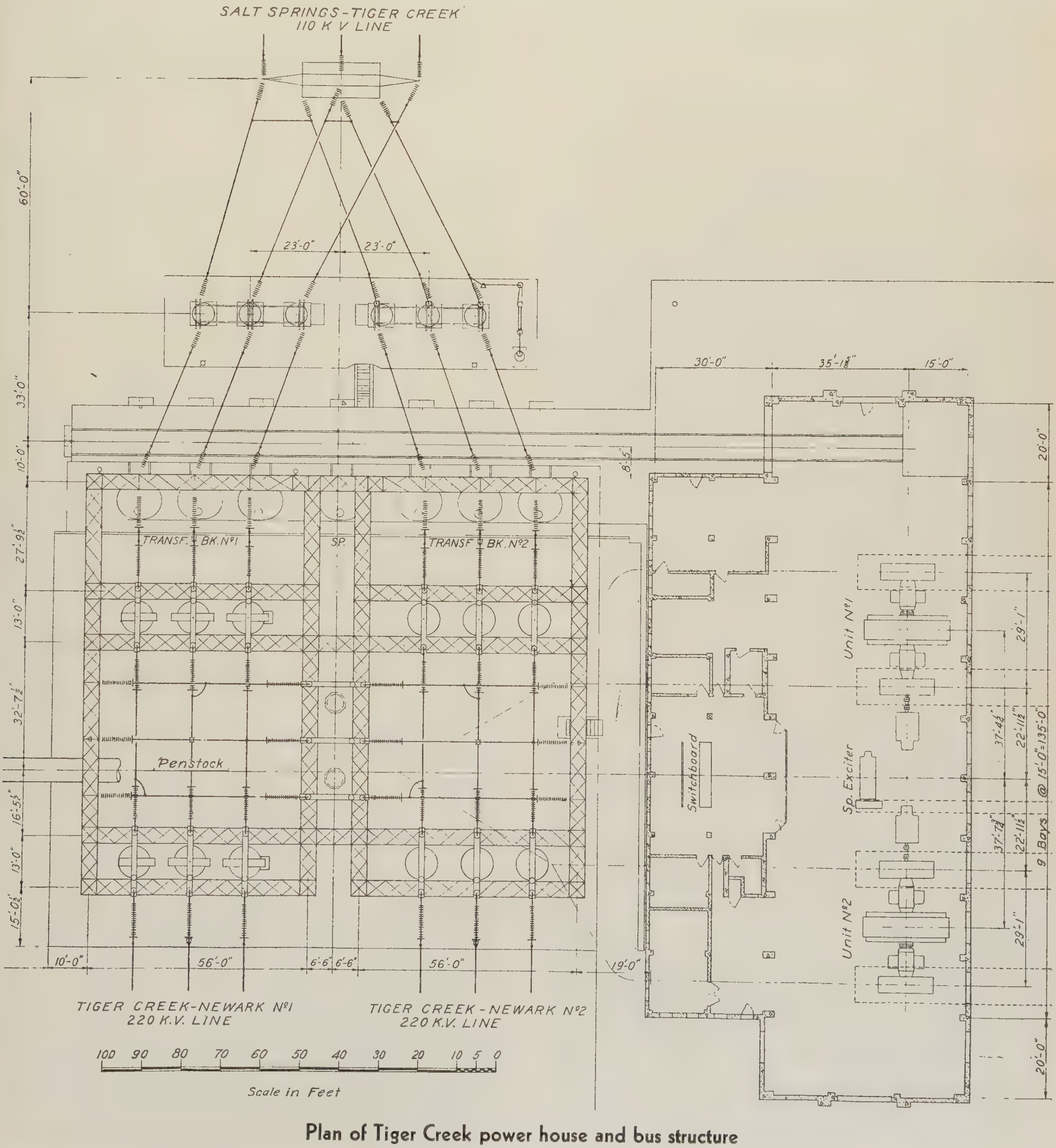
Simplicity of plant layout was the aim throughout the design of Tiger Creek power house. Each generator with its associated step-up transformer bank is considered as a unit; there is no oil circuit breaker between the generator and the low-voltage side of the transformer. The electrical connections are extremely simple. A steel bus structure containing four 11-kv. truck-type oil circuit breakers is installed in the bus room, two of the breakers serving to connect the generators to an 11-kv. bus for the purpose of synchronizing before closing the main 220-kv. breakers. When the units are in parallel on the high-voltage side of the transformers, one of these breakers is opened separating the units on the generator side; the other remains closed to supply power for station requirements. The remaining two truck-type breakers are for the station power transformer bank. As at Salt Springs, these four breakers are interchangeable.

Each generator is provided with a direct-connected exciter and pilot exciter both controlled by voltage regulators. A spare exciter set is installed between the main generating units and arranged to be driven either by an impulse waterwheel or an induction motor. Each waterwheel has its individual governor oil pressure system with duplicate oil pumps, one motor driven and the other driven by a small impulse wheel. For

normal operation the motor-driven pump maintains the oil pressure, but suitable controls have been provided so that any failure of supply from the motor-driven pump automatically will start the water-driven pump to reestablish governor oil pressure.

The switchboard is in the switch and bus section of the power house on the level of the generator floor and midway between the units. To facilitate operation all equipment requiring frequent attention has been installed on the main power house floor, and considerable thought has been given to the convenience of the location of equipment from an operating standpoint. Equipment requiring infrequent inspection has been placed on the second floor of the power house and the general layout of the plant has followed the idea of making operation possible with a normal shift consisting of a first and second operator. The duty of the first operator will be the switchboard, while the second operator will be available for oiling and operation of the disconnecting switches in the outdoor switch yard.

The two banks of step-up transformers have combined double and auto-transformer windings, each



Plan of Tiger Creek power house and bus structure

bank providing both a 30,000-kva. capacity for stepping up the incoming power from Salt Springs power house from 107.5 to 215 kv., and a 30,000-kva. tertiary capacity sufficient to care for one Tiger Creek generator. The transformer banks therefore will have a total capacity of 60,000 kva. each. A spare unit is arranged for emergency substitution in place of any of the six regular units.

To regulate water discharge from Tiger Creek plant for diversion to the next lower plant, an afterbay has been provided by constructing in the Mokelumne River some 2 mi. below the plant a concrete arch dam about 100 ft. high. This dam caused the flooding of about 100 acres, creating a reservoir of 300-acre-ft. capacity in the top 3 ft.

West Point Power House

The last of the four power houses in the Mokelumne project, but the one immediately downstream from Tiger Creek, will be known as West Point power house, the location and construction of which was influenced by the existence of the present Electra power house. Diversion of water for West Point will be made from Tiger Creek afterbay about 3 ft. from the top of the dam into a 4-mi. conduit which will connect with the West Point penstock providing a 285-ft. static head. No forebay facilities being available, the plant will be designed to operate at 100 per cent load factor with a maximum flow of 575 sec-ft. A single vertical turbine driving a 15,000-kva., 11-kv. generator will be installed and the plant will be laid out for full automatic operation, with certain controls carried back to Tiger Creek power house. Generated power will be stepped up to 60 kv. to supply the demands now served by the present Electra plant, making West Point the only plant on the Mokelumne system not regularly feeding into the 220-kv. transmission system.

Electra Power House

Construction of the new Electra power house and conduit will follow immediately upon the completion of the Salt Springs-Tiger Creek development—probably in the fall of 1931. The static head to be developed at Electra is 1,265 ft. and the water flow 575 sec-ft. The two waterwheels will have a slightly greater horsepower rating than Tiger Creek, 37,500 hp. each at 225 r. p. m., but their almost identical physical dimensions will permit the construction of a duplicate power house. One factor is present in the Electra designs which was not at Tiger Creek; the presence of an excellent 1,158-acre-ft. forebay in Lake Tabeaud. This will permit considerable peaking at Electra and all designs are being made so that a third unit for peaking may be added later.

Power generated at Electra will be stepped up through two banks of transformers to 220 kv. for connection to the Tiger Creek-Newark transmission lines. It will be necessary also to provide for supplying power to the 60-kv. and 17-kv. systems now taking the output from the present Electra plant.

General

The peak load on the system of the Pacific Gas and Electric Company and associated companies reached 853,300 kw. July 1930. In the decade 1920-1930 the load on the system has grown at the average annual rate of 7.25 per cent, requiring the addition of some 40,000 kw. of new generating capacity each year. The new capacity was provided partly in steam-driven units and partly in hydro, the ratio of the two types of prime movers for the entire system up to 1930 being approximately two to five.

Prior to the advent of natural gas as a fuel in central California, and before the recent great increased steam plant economies, hydroelectric plants with their relatively long transmission lines were able to deliver power to the consumer at prices which made the development of the hydro resources of the state economically attractive. Now the picture has changed and natural gas has placed the cost of power from the two sources approximately on a par. A relatively slight variation either way in the cost of fuel may have great influence on the type of future generating equipment.

The power peak growth of the system for the next five years will approximate 50,000 kw. annually. This is favorable to hydroelectric power in that it permits full development of a river over a short period of time, thus dividing the cost of water storage among all plants on the stream and reducing the fixed charges per kw-hr. generated. In order to produce hydroelectric power on the most economical basis, hydro plants in California must operate on the highest possible load factor. The average annual load factor for the system of the Pacific Gas and Electric Company is approximately 62 per cent and all studies for the plants on the Mokelumne River, with the exception of the 100 per cent load factor plant at West Point, were on the basis of 85 per cent load factor. Such operation will be possible in each year with normal or above normal rainfall. Studies of runoff over a 24-year period have indicated that the average annual output will be 88 per cent of the maximum possible during the wettest year recorded, with a 47 per cent output during the extreme dry year. On the Mokelumne River normal plant operation will be on base load with system peaks carried by steam. This condition may be reversed on extreme dry years when the economic use of stored water dictates its use for the carrying of peak loads.

The total cost of the Mokelumne River development as here outlined, including transmission and the increased capacity at Newark Substation, is practically \$39,000,000. The entire design and construction of the project have been carried out by the regular personnel of the Pacific Gas and Electric Company.

Power Distribution from Mokelumne Plants

To carry 150,000 kw. of hydroelectric energy from the mountains of California to the San Francisco Bay area and there distribute it, required the construction of an entirely new 220-kv. transmission system and the development of a one-time 60-kv. substation into a major system switching center interconnecting 60-, 110-, and 220-kv. lines.

By
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As INDICATED in the preceding article which describes the power development features of the Mokelumne River project of the Pacific Gas & Electric Company (Calif.) one of the most unique features of the project was the fact that it required the building of practically a complete new system within a system already operating. The transmission and distribution phase of the project involved the construction of 17 mi. of 110-kv. single-circuit line to interconnect the upper two generating plants; the construction of 109 mi. of twin-circuit 220-kv. transmission line to a San Francisco Bay terminal station, the stringing of a 100-mi. 220-kv. intersystem tie line (on existing towers) and the creation of a 249,000-kva. dual terminal station providing intrasystem ties; and accommodating the two 220-kv. Mokelumne line, sixteen 110-kv. circuits, and three 60-kv. circuits.

In developing this dual substation, which is located at Newark, an unusual situation was involved. Other stations previously chosen as transmission line centers and designed with the idea of future expansion in many cases had failed to develop their expected importance due to the shifting of load centers or to changes in transmission voltage. Although not originally considered as likely to be greatly expanded, Newark station has grown through a step-by-step process (including the Mokelumne River project as a major part) into the largest and most important transmission center on the entire system. It is worthy of comment that in spite of the many additions and the changing importance of its position, the flexibility of the unit structures used has allowed it to develop into a rational arrangement.

As a result of an extended economics study and a review of the operating facilities involved, a nominal line voltage of 220 kv. was adopted. To facilitate future interconnection with the Vaca-Dixon substation (southern terminus of the company's 220-kv. Pit River system) the receiving voltage at Newark substation (the San Francisco Bay terminal station) was set at 200 kv. To enable the generators to operate at unity or lagging power factor and thereby require the high excitation essential for good stability, the voltage at the Tiger Creek end of the line was set at 215 kv., thus providing for charging current to be supplied from the receiving end.

Tower Design

The 220-kv. Mokelumne River transmission line starts from Tiger Creek power house switchyard at El. 2,400, terminates at Newark substation at El. 7, and in general involves two types of towers, two types of conductors, three different loading zones, and three zones of insulation.

In the heavy loading area, including the first 16 mi. of line out from Tiger Creek, there are two lines of single-circuit snow-type towers set in concrete foundations. These towers accommodate a horizontal configuration providing a 20-ft. spacing between conductors, and are designed for a loading of ½ in. of ice, and a wind loading of 6 lb. per sq. ft. at 0 deg. fahr. (Fig. 2.)

The next 11 mi. of line through the lower foot-hills are designed for a medium loading of ¼ in. of ice and a wind load of 6 lb. per sq. ft. at 0 deg. fahr. In that section of the line there are twin-circuit steel towers set in concrete foundations. These towers permit a semi-vertical configuration for both circuits, providing a 15-ft. vertical clearance between conductors, a 28-ft. horizontal separation between the top wires and the bottom wires of the two circuits, and a 38-ft. separation between the center wires. (Fig. 3–left.)

The remaining 82 mi. of line comprises the light-loading area where the design is based upon a wind load of 8 lb. per sq. ft. and 25 deg. fahr. In the upper 53 mi. section of this portion of the line, which crosses California's great central valley of the San Joaquin, the towers used are the same as in the previous 11-mi. section except that the middle conductors are not offset, the configuration being strictly vertical. The remaining 29-mi. section of line traverses a hilly country which is considered to be a fog area. In this lower section of the line the tower structures have the same steel below the crossarms as in the two-circuit structures of the previous section. With the upper tower design modified to provide a vertical separation of 18 ft.

From "Power Transmission and Distribution From the Mokelumne River Development of the Pacific Gas and Electric Company," (No. 31-131) presented at the A. I. E. E. Pacific Coast convention, Lake Tahoe, Calif., August 25-28, 1931.

Fig. 1. Map showing the 110-, 165-, and 220-kv. transmission system of the Pacific Gas and Electric Company and the San Joaquin Light & Power Corporation

The Mokelumne circuits may be traced as the heavy lines starting at Salt Springs. The triangles indicate substations; the solid circles, major steam plants; the heavy open circles, proposed steam plants. Distances may be scaled at about 98 mi. per in. as shown

between conductors and a horizontal separation of 33 ft. between circuits. These larger spacings are used to permit the required increase in insulation. (Fig. 3-right.)

In the 17 mi. of 110-kv. line which interconnects the Salt Springs power house with the Tiger Creek power house, single-circuit snow-type towers set in concrete foundations accommodate a flat configuration of conductors providing a 14.5-ft. horizontal spacing between conductors. This line starts at El. 3,800, reaches El. 5,000 at about its midpoint, and terminates at Tiger Creek at El. 2,400.

Normal spans on the 110-kv. line are 600 ft. although there are several long spans ranging between 1,500 and 2,100 ft. On the 220-kv. main transmission line the normal span for snow-type towers is 600 ft.; for the twin-circuit towers 800 ft. Extra long spans in the 220-kv. line range from 1,000 to 1,800 ft. in length.

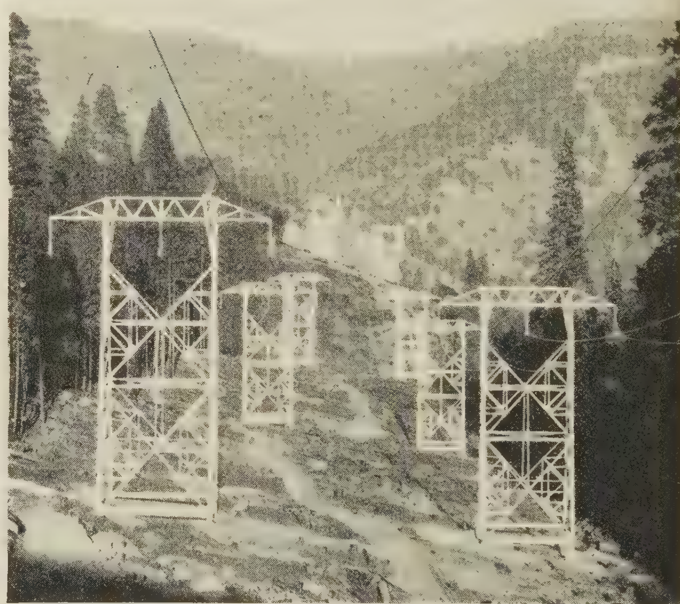

Fig. 2. 220-kv. tower line near Tiger Creek power house

Towers of the same type but of increased strength are used where necessity requires it, but no dead-ends or semi-strains are used unless required for angles, upstrains, or crossings. Transposition throughout are of the rolling type without dead-ends. (See Fig. 4.)

Conductors

As a result of extensive tests made at the Ryan laboratory, Stanford University (Calif.) two different standard types of cables were chosen for the 220-kv. line. Throughout the heavy- and medium-loading area comprising the upper 27 mi. of the line, 518,000-cir. mil steel-reinforced aluminum cable, having an outside diameter of 1 in., was selected. The stranded steel core in this cable is approximately ⅝ in. in diameter. In the lower 82-mi. section of the line where conductivity as well as corona loss were of primary importance, 500,000-cir. mil hollow-core copper conductor of 1-in. outside diameter was chosen. This cable consists of two layers of wires laid over a twisted copper I-beam.

With the aluminum cable, standard compression joints designed by the cable manufacturer were used,

pressed on in the field for all splices. For the copper cable, screw joint splices were used comprising threaded lugs drawn on the end of the conductor at the factory, and connected in the field by means of a sleeve nut reverse threaded to obviate twisting the cable.

Standard bolted *J*- and *U*-bolt clamps were used on both the aluminum and copper, and both for section and dead-end construction, thus eliminating any cutting of the wires. Particular attention was paid to the choice of clamps for the aluminum conductor so that they would fit the conductor as closely as possible for not less than 80 per cent of its total circumference.

On the 17-mi. 110-kv. line above Tiger Creek plant, the normal conductor is 4/0, 7-strand medium-hard-drawn bare copper, except in some long spans where 4/0 "Hitenso" copper is used to meet strength requirements. All splices are of the drawn-joint type and were put on in the field with a portable draw-bench built for the purpose.

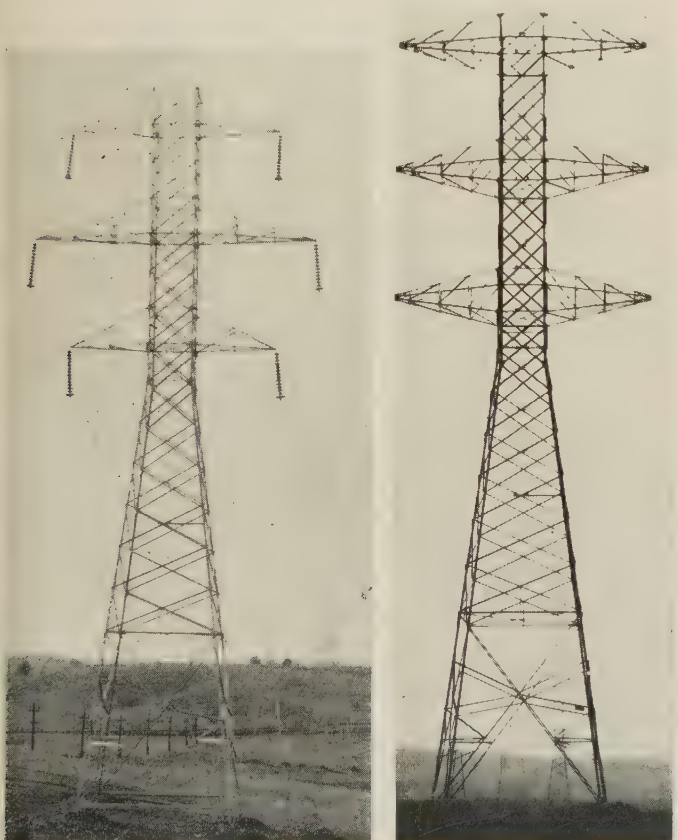

Fig. 3. Typical 220-kv. towers for medium-load area (left) and for fog area (right)

These have been reproduced approximately to scale to show the differences in relative dimensions. Careful scrutiny may reveal transposition towers in the distance (left)

Insulation

Although ball-and-socket type insulators were used throughout on the 220-kv. transmission line, the gradations of insulation to meet local conditions divide the line in general into three sections: standard, light fog and heavy fog. The upper 79-mi. section of the line from Tiger Creek down across the San Joaquin Valley comprises the standard section, where thirteen standard-strength 10-in suspension type insulator units with 5.5-in. spacing in the suspension string, and thirteen high-strength 11-in. units with 7-in. spacing in the dead-end string, are used on both circuits.

In the two fog areas, depending upon the fog density expected, from seventeen to twenty standard insulator units are used on one circuit, and from eleven to fourteen fog-type units of two different designs are used on the other circuit. The lengths of the insulator strings of each type were laid out in proportion to the recommended insulating value. From an experimental standpoint this directly competitive insulation installation should reveal some very useful operating information as to the relative values of the standard and fog-type units under comparable and normal operating conditions.

On the 110-kv. line above Tiger Creek standard-strength suspension type insulator strings made up of eight 10-in. units were used for all suspension points, with nine units for most of the dead-ends. Where the strain was excessive such as at high points in the line, high-strength insulators in strings of nine 11-in. units were used.

Bellota-San Joaquin Tie Line

At Bellota substation which is situated at a point about 42 mi. from the Tiger Creek plant, the 220-kv. Mokelumne lines cross the Feather River line. There both of the 220-kv. Mokelumne circuits are tapped to provide a feed into a single circuit which was strung about 100 mi. on the No. 2 position of the existing 165-kv. line connecting with the San Joaquin Light and Power Corporation's substation near Fresno.

The conductor used for this tie line is hollow-core copper of the same specification as that used on the

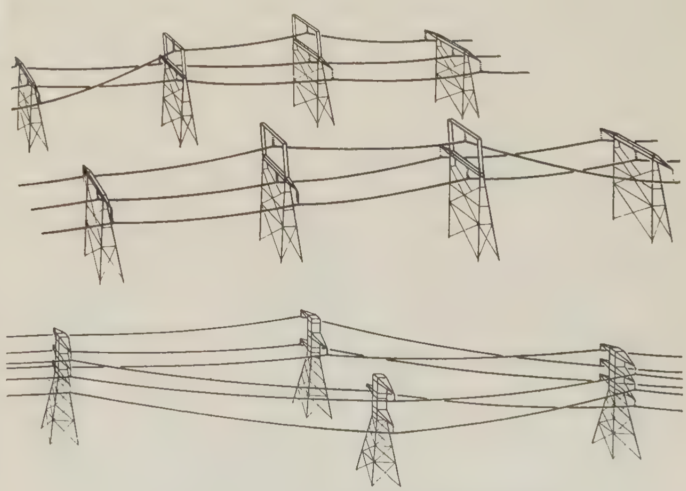

Fig. 4. 220-kv. transposition schemes

Mokelumne circuit. Insulation also is typical of Mokelumne specifications comprising fourteen standard units in suspension and fourteen high-strength units in dead-end string. A combined static shield and arcing ring is used on each insulator string. All of the switching at the Bellota substation will be handled by remote control from Stockton substation about 20 mi. away.

Newark Substation

Newark substation, the San Francisco Bay terminus of the Mokelumne transmission system, long has been the distributing point of Mokelumne River power (originally from Electra plant). However, growth to its present proportions was not expected when it was developed in 1919 as an ordinary 60-kv. switching and power distributing station. Nevertheless, as a result of the unit type of structure adopted in the original design of Newark station it has been possible to evolve a continuously modern station capable of handling the ever-increasing power concentration thrust upon it. With the advent of 150,000 kw. from the Mokelumne River development the principal of a dual station has been developed.

That an economical and yet flexible switching arrangement might be provided for handling the 220-kv. circuits, a double bus is used with bus selector air switches and a single oil circuit breaker for each transmission line, and transformer bank. With this arrangement a circuit can be connected to both buses, or to either bus, as switching requirements may dictate. The 220-kv. bus structure provides switching facilities for the operation of two transmission lines, three transformer banks, a bus-paralleling oil circuit breaker, and carrier-current telephone coupling equipment.

General dimensions of the bus structure are: length 354 ft., width 116 ft., height of center dead-end frame 64 ft. The structure is of galvanized steel. This design provides for the buses and selector switches to be placed well above ground elevation. The six 650,000-cir. mil concentric-lay copper cable conductors comprising the double bus are strung in tension, dead-ended at each end of the bus structure, and supported in between on the cross frame with pillar-type insulators at each bay. (Fig. 5.)

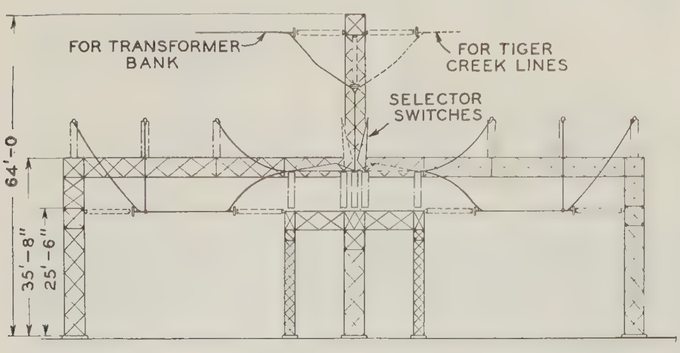

Fig. 5. Section through Newark 220-kv. bus structure

The 400-ampere selector switches are of the vertical-break type, each single-pole assembly of which consists of two single-pole air switches mounted on a common structural-steel base and insulated by five insulator posts per pole. The three poles of each selector switch are actuated by a single manually-operated control handle at the bottom of the supporting column adjacent to the switch assembly.

The two incoming 220-kv. lines and the bus tie breaker are accommodated on one side of the bus structure, while the three transformer banks are accommodated on the other side.

This arrangement of a 220-kv. oil circuit breaker complete with by-pass and disconnecting switches is similar to that employed at other 220-kv. stations of the Pacific Gas & Electric Company, (see Fig. 6) with the exception that a vertical-break by-pass switch is used instead of the so-called "roller-skate" switch previously used. Inverted switches of the latter type are used as disconnecting switches, however. On the towers which control the 220-kv. line, grounding

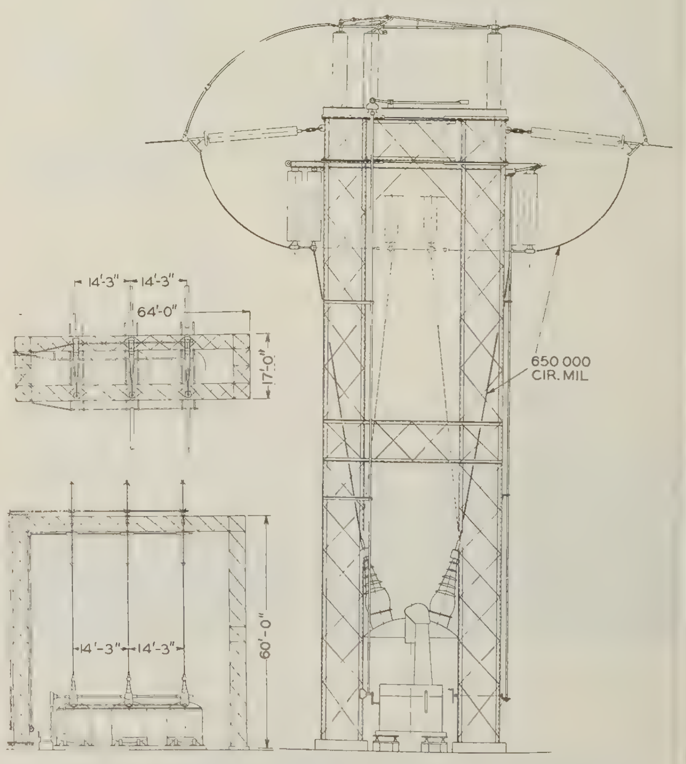

Fig. 6. Typical Newark 220-kv. self-contained switch structure

switches are installed and mounted on the base of the by-pass switches. Grounding is effected by closing the grounding switch into a contact on the center post of the by-pass switch, subject, of course, to suitable interlock. All switches are actuated by means of rotary shafts and are hand operated. Within the galvanized tower structure is enclosed a 6-break

600-ampere 220-kv. oil circuit breaker mounted with the poles of the breaker on 14.25 ft. centers.

Each of the single-phase 200/110-kv. auto-transformers is rated at 18,000 kva. and is equipped with a tertiary winding to supply 11.5 kv. for synchronous condenser operation. Partial cooling is accomplished with radiators; additional cooling is obtained by means of hood-type radiator air-blast equipment. The transformer output at 110 kv. is delivered to the 110-kv. bus. One spare transformer unit is provided with a range which will permit it to be exchanged conveniently for any of the nine units in the three banks, which may require removal from service. To facilitate transformer handling a permanent handling house has been constructed and equipped with a traveling crane and all necessary tackle for untanking.

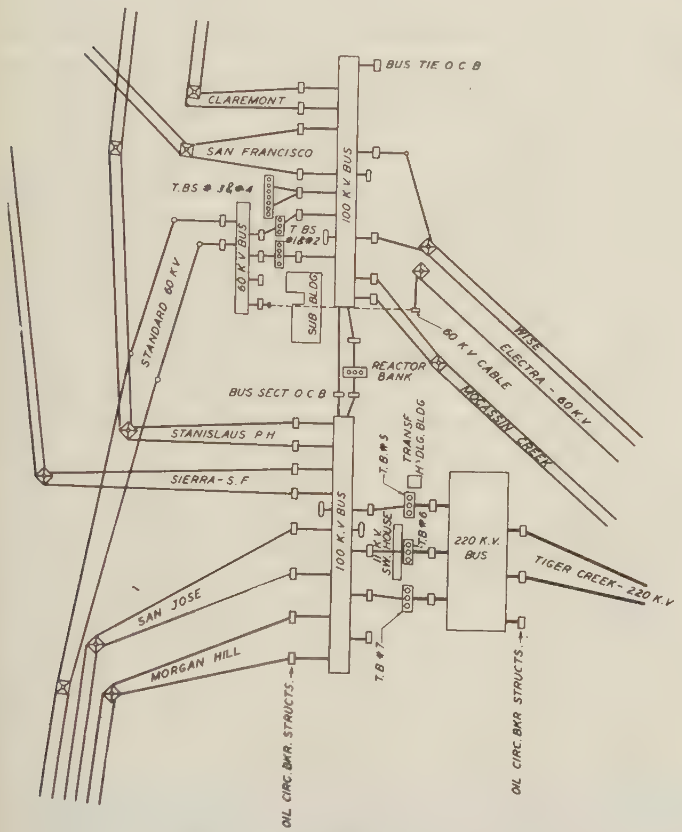

Fig. 7. General arrangement of Newark substation

Although it has developed far beyond original expectancies, the unit-type of structures consistently used have enabled the evolution of a very orderly and logically arranged station

The 110-kv. double bus also provides the single circuit breaker and switching arrangement described for the 220-kv. bus. The buses and selector switches are mounted on a rigid steel framework with all live parts well isolated by elevation. The bus conductors consist of 2-in. outside diameter, 14-gage copper tubing. Both the bus and the selector switch insulators are pillars made up of two 4-part units per post, each unit being 20 in. high. The 110-kv. bus is divided into two sections, and provision is made for controlling twelve circuits in each section.

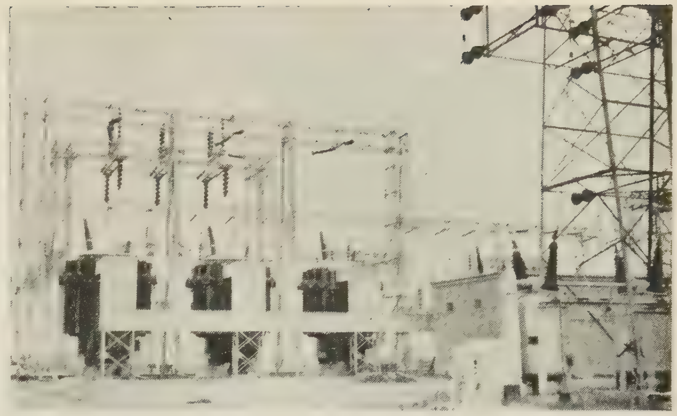

Fig. 8. Rear elevation of the 220/110/11-kv. Newark transformers

Because of the large power concentration now effected at Newark, current limiting reactors have been installed in one of the buses between the bus sections. (See Fig. 7.) Each of these single-phase 110-kv. 5,400-kva. reactor units is rated at 60 ohms reactance, and 300 amperes continuous duty, with an overload capacity of 1,060 amperes for three sec. Attention is called to the fact that this substation is essentially two stations, the dividing line being the reactor bank between the 110-kv. bus sections. One part comprises the older equipment consisting of several 110-kv. circuits, and transformer banks feeding 60-kv. circuits and synchronous condensers. The second part of the station comprises the new 220-kv. bus, together with the associated 220/110-kv. transformers, 110-kv. circuits, and related synchronous condenser equipment.

Consistent with the dual station principle it was necessary to make the switchboard in two sections, each section arranged to control its respective group of equipment. Because of the large number of circuits involved it was necessary to use a bench-board and two vertical boards, one for the indicating instruments, and one for relay equipment. To reduce the over-all length required in the switchboard, equipment for two circuits is mounted on one panel, one circuit above the other. This arrangement accomplished the necessary longitudinal reduction, but required panels 100 in. high, instead of the more conventional 90-in. boards. The entire switchboard is constructed of ⅛-in. sheet steel.

Synchronous condenser equipment for the new station consists of two 25,000-kva. 720-r.p.m. 11.5-kv. three-phase, 60-cycle machines of the totally enclosed ventilated type equipped with surface air coolers. Pedestal bearings are provided with passages for cooling water in the bearing shells. For fire-fighting water at 25 lb. per sq. in. will be used, distributed through manifolds installed at the end of the stator frame around the air gap. Each condenser is provided with a main and a subexciter. One machine was built

with a 1,500-hp. synchronous driving motor to provide a convenient means of line and relay testing. This feature is particularly applicable to Newark station with its three main transformer banks, because with such grouping a bank can be released for build-up tests without great impairment of effective station capacity.

Switching equipment used in connection with the operation of the synchronous condensers is of the metal enclosed type using truck-type oil circuit breakers, and motor operated disconnecting switches. All of this equipment is housed in a small building adjacent to the 220-kv. transformers with underground lead covered cables providing the connections between switching equipment and condensers.

In unifying the existing and new control equipment in a new switchboard room the problem incident to conduit arrangements required that the transfer of control circuits from the old station to the new be made without service interruption. This was facilitated to a large extent by use of a control circuit terminal room directly beneath the switchboard room. All switchboard wires and control circuits were brought to terminal blocks and all cut-over work and testing procedure correspondingly readily executed.

Carrier-current telephone equipment installed will provide for communication over the 220-kv. lines to Tiger Creek power house, and also furnish communication circuits over the 110-kv. lines to station *J* in Oakland, whence a wire line extension is made to the load dispatcher's office. Coupling condensers on the 110-kv. and 220-kv. buses are so connected that the dispatcher may communicate directly from Oakland to Tiger Creek power house without assistance from the Newark operator.

As pointed out above, Newark substation as it now is constituted stands as the result of many additions. In spite of this, however, the flexibility of the unit structures used has allowed it to develop into a rational arrangement, and except for the old switchboard just replaced, every structure, whether installed in 1919 or in 1931, is functioning in its logical location as part of a modern substation.

In view of the fact that it is impossible to make accurate predictions as to the location of future load growth and the routing of transmission circuits to supply this load, it becomes necessary to design and construct major transmission substations in such a manner that they can be extended readily in any direction without the necessity of moving existing equipment or giving the appearance of a patched up job. Proper thought given to the design of the original installation will permit the achievement of these aims even though the station grows far in excess of any preconceived ideas as to its probable future importance. Satisfactory operation under any circumstance requires a simple and easily followed arrangement of equipment.

Riverbend Steam-Electric Generating Station

THIS newest steam station of the Duke Power Company, Charlotte, N. C., was placed in operation in October 1929 with an initial capacity of 137,500 kva., about one-fourth of the expected ultimate. Each of the two generating units operates at 1,800 r. p. m. with steam at 425 lb. gage and 725 deg. fahr., delivering energy at 13 kv. Each of the four cross-drum boilers has 35,500 sq. ft. of heating surface and is designed for 500-lb. working pressure; maximum furnace heat liberation is 30,000 B. t. u. per hr. per cu. ft. of volume. Pulverized coal is burned; the supply being received by rail. With this station the steam-electric capacity of the Duke system passed the 50-per cent point.

Industry's New Responsibilities

In an older day those who failed to store their food at harvest time did not fare so well during the winter; now, those who fail to accumulate at least a moderate surplus during times of plenty suffer accordingly during the cyclic "depressions." A thoughtful industrial leader, himself once a farm boy, here makes some interesting comparisons.

By
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Associate A. I. E. E.
Chairman of the Board
Westinghouse E. & M. Co.

IN ITS BEGINNING this country was sparsely settled—dotted with small isolated communities tied together by waterways. Even the post roads were impassable a large part of the year. Not until 1830 did the railroads make their appearance. In 1885 the electric street car superseded the old horse cars and shortly thereafter we saw our great interurban development. The next step forward in transportation was in 1900 which marked the start of the era of the automobile. Since that time the transformation in our manner of living has been almost unbelievable.

The Passing of Individualism

It is interesting to note the shift in responsibility from the individual to industry which has taken place, even in the short space of my own life. In our early days we were tremendously individualistic. That was a basic characteristic of the founders of this nation. Every one stood on his own feet, or tried to do so, and was proud of his efforts. Each family was a group of home industries complete and almost self-supporting. Little had to be bought from the general store. Almost everything used was produced by the family. The women wove the fabrics for clothing from the wool, cotton, and hemp raised on the place. The men and boys were their own carpenters, blacksmiths, and shoemakers.

My father expected to take care of himself and his family without asking for help from anyone. He did it largely by working hard all during the spring, summer and fall. He loafed, or at least did not work so hard, during the winter. In the fall I remember we used to imitate the thrifty squirrel and stored up a supply of food to last until spring. With wood and coal in the shed, potatoes and other vegetables in the cellar, sausage, ham, and corned beef available in the meat-house, we faced the winter season of unemployment with something considerably less than dread—in fact, if I caught the spirit correctly as a boy, we really enjoyed it.

These were my personal experiences as a boy and they may not be typical of this whole country especially in the larger cities. Yet I have found them duplicated by so many other people who were reared as I was that I am inclined to think that my boyhood life represents a common picture of the independence of the individual of earlier generations. It was perhaps inevitable that this point of view should change—but it will be too bad to lose it entirely.

From Agriculture to Industry

After the Civil War in this country we commenced to be less and less an agricultural people and more and more an industrial nation. With the coming of mass production in the last thirty years, and other changes incident to it, population became congested in great cities.

Today the average home-owner has no place in which to store fuel or food beyond a supply for a short period. Gone are the days when the unit of purchase was a barrel of flour, a barrel of sugar. The unit of purchase is the smallest available package. Chain stores are conveniently located at almost every city corner and country cross-road. The railroads, trucks and passenger cars have made the distribution of goods both easy and quick, and it has been estimated that even in a large city like New York there is available less than a week's supply of food.

The average family today exists from hand to mouth and would not know how to live otherwise even if it so desired. When the periods of unemployment come, whether they be seasonal as in the older days, or due to economic depression, the average man has no fuel or food stored away to keep him and his family alive and comfortable while he searches for work to do.

If he was thrifty when business was booming, he has a savings account which he can use in bad times to buy the necessary food and clothing and keep a roof over his family. Thousands of persons have savings accounts as the statistics bear witness, yet unfortunately it just does not seem natural for human beings to be thrifty and save money while they are earning it. Certainly it does not appear that they save money now as they used to save food and fuel against the winter time of need. As a result many thousands of people today have no resources beyond their immediate needs.

From a booklet published by the Westinghouse Electric & Manufacturing Company and available upon application to that company at 150 Broadway, New York, N. Y.

The Burden of the Improvident

There seems to be the growing tendency to try to shift to the shoulders of each industry the burden of providing for those improvident individuals, employed by that particular industry, who are unable to care for themselves in times of need. In certain circles apparently serious consideration is being given to the paternalistic proposals that big business, or the government, assume many of the obligations formerly recognized by the individual as his own personal burden and his own responsibility. Some states have enthusiastically adopted pension bills for mothers, for widows, and for old people; other states are giving earnest thought and study to compulsory unemployment insurance.

Meanwhile industry as a whole has voluntarily done a great deal to relieve its workmen of more and more of their former responsibilities and obligations. Most progressive companies can boast of departments which provide education, housing, a bonus, insurance, savings, old age pensions, etc., for their employees. Many companies in going into this general welfare work have taken the advanced stand, and recognized the principle that a loyal, faithful employee, in addition to his daily wage is entitled to an opportunity to participate in some form, depending upon his relative position, in the financial progress of the company for which he works.

Many companies are assuming also a large part of the cost of providing for employees during the present period of unemployment. It has become the accepted practise to spread out the available work in the plants and factories among as many men as practical although the operating results may be uneconomical for the company. These things are mentioned merely as illustrating the acceptance by industry of this added burden of unemployment.

Industry Founded on Savings

The tragedy of the situation lies in the fact that big business, having assumed all these additional tasks, is just about as helpless as the employee. Every industry is affected differently by depression. Seemingly none is immune. All are influenced to the extent of having income seriously curtailed, and, in many cases, profits entirely eliminated. No company, large or small, seems to be financially strong enough, or lucky enough, to prevent serious shrinkage of its liquid resources in times of depression.

Under such circumstances the management of every company in every industry is confronted with the difficult and serious problem of deciding what course should be followed. Assuming that every well-managed company accumulated out of earnings some surplus during prosperous times, the question arises immediately as to how this surplus should be used when times are not so prosperous. The company must conduct its affairs in such a way as to maintain its credit. There must be money with which to pay honest debts—otherwise, the company will soon cease to function and it will not be able to meet any of the many obligations which it has assumed.

In addition to the creditors and the employees, there are the stockholders who have equities to be recognized. As the owners of the business, they are partners in the enterprise. Their just rights should not be ignored. Sometimes it would seem, however, from the careless talk indulged in by those who are not well informed in fact or theory, that stockholders are not entitled to any consideration. Those who voice such unsound opinions overlook the fact that stockholders, generally speaking, are employees of the company itself or are employed by some other company. At least in part, they are dependent upon their dividends just as they are on their wages for their living.

The money these people have invested in securities has to a large degree made possible the very existence of industry. The holdings of the stock of a company often represents the savings which the shareholder has made against the inevitable rainy day.

An investment is the dedication of the surplus of today to the needs of tomorrow—the insurance of ready cash to meet some form of future emergency. If that is a correct definition of an investment it may take many different forms with different people.

After a fashion, the investment by the stockholder is comparable to the stores of food and fuel which were commonly made in more primitive civilization, such as, for instance, my own boyhood days. If the rights of security-holders are not to be respected, then investors generally will cease to put their savings into industry; and there will be no industry. Further, there will be no safe place to invest one's savings.

The Human Equation

I fully recognize that the employees are one of the real assets of a going business—in many cases its most valuable asset—and their well being is of prime importance. People are too apt to think of big business as a piece of automatic machinery—soulless. In my opinion, the reverse is true. Big business must be human if it is going to succeed permanently because what makes the wheels go round will always be human beings—employees who are investing part or all of their life work in the service of that institution.

Business generally recognizes that regardless of the millions of money that have been put into plants and machinery, the ability to earn profits on that investment depends upon the loyalty and the efficiency of the employees.

It has been said, in substance, that public good will towards a company and its products, while intangible working capital, has as distinct earning power as the plants, which would soon turn to lifeless material were it not for the livening infleunce of these intangible values which, in the final analysis, are the contributions of the employees of a company.

The management of every concern always has before it the problem of dealing fairly with all parties involved —giving due consideration, of course, to the resources at its command. In periods of depression the task is made extremely difficult because no one can predict with any accuracy the length of time the set-back may continue. Consequently the management of a company does not know how long the earnings may continue below normal and how long it may be necessary to lend assistance to its employees out of work.

A Mutual Problem

In the years to come if the business of this country follows the upward curve of normal progress, as it has in past decades; and, if business flourishes with only occasional periods of depression and unemployment, then the recent burdens added to industry will not become too heavy. On the other hand, if these periods of recession come too close together and increase in severity, then industry may not be able to carry on its usual normal responsibilities of payments to creditors, wages to employees, dividends to stockholders, plus the added burden of supporting the individuals who cannot provide for themselves in times of unemployment.

It would be most constructive at this time if there could be developed a more tolerant attitude toward this problem on the part of both industry and the individuals involved. The whole world is afflicted by a new set of conditions. The right cure will be beneficial to every man, woman and child; therefore, any proposal that may lead to progress in that direction should and will, I am sure, receive open-minded consideration.

To me it seems highly desirable that we keep alive the old-fashioned individualistic spirit of looking after one's self. It is going to be our salvation. It is one of our greatest inheritances from the founders of this country. After all, no one is as much interested in me as I am in myself. If each and every one of us made it our principal business to look after himself as well as a reasonably prudent man should, there would not be so much required of either industry or the state. That is what I would define as constructive selfishness.

Economic Laws are Insuperable

The picture is not without its bright side. There is ample reason to be cheerful. This country will weather this storm as it has successfully weathered every other great economic disorder of the past. And each time business has emerged upon a broader basis and a more solid foundation. The element of time is our worry. If we knew definitely when things were going to turn for the better the battle would be won and industry could plan accordingly. The rest would be easy. Certainly the worst is behind us and there is plenty of evidence for those who will look, that in certain lines, at least, improvement has commenced.

If the whole is greater than the sum total of the parts in periods of prosperity then the reverse is certainly true in times of depression. Corporations being but aggregations of people are subject to the same economic laws as individuals. Those succeed who perform or serve acceptably, and those grow more rapidly and become the greatest who serve best.

There is no Shortcut

Let us face the present unpleasant facts calmly and with courage. Let us be honest with ourselves.

There is no panacea for the present ills of all industry —no magic formula by which miracles may come to pass. Business will not change overnight, but it will be better tomorrow or the next day.

The desired objectives may be accomplished only by hard, consistent, endless work by us as individuals. There is no shortcut and we all know that is the truth.

Stability of Transmission Lines

STABILITY of power transmission "between two power plants operating in parallel is of utmost importance in providing uninterrupted power supply during system disturbances and abnormal operating conditions which may be due to short circuits, switching, and a variety of other causes," states Alexander Smouroff (F'24) professor, Electrotechnical Institute, Leningrad, U. S. S. R., in introducing a recent manuscript dealing with the subject of static stability. This paper represents another mathematical contribution to the analytical solution of the transmission stability problem and, being written by a prominent foreign engineer, represents a point of view somewhat different from that of American engineers.

The inherent dynamic stability and the artificial stability of a system are discussed, and a method is given for the determination of the dynamic stability of a system. The application of the proposed method is illustrated by practical examples.

"Stability of Transmission" by Alexander Smouroff, professor, Electrotechnical Institute, Leningrad, U. S. S. R., from which the above brief abstract has been prepared, has been placed on file (in manuscript form) for reference in the Engineering Societies Library, 29 West 39th Street, New York, N. Y. The complete manuscript is available for reference or photostat copies may be obtained from the library.

The paper concludes with an appendix in which formulas are given by which the maximum power output for stable operation of each of two plants operating in parallel may be determined as a function of the phase-displacement angle between the induced voltages of both plants. These equations give a criterion of stability and should prove of value in determinations of this character.

Economic Loading of Generating Stations

The problem of properly loading generating stations has evinced a gradual but continuous advancement as knowledge of the characteristics of power station equipment increased and methods of interpreting these progressed. The increment method has proved to be the most economical scheme thus far introduced.

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CORRECT LOADING of generating stations has assumed increased importance with interconnections becoming common, especially since the operation and control of boilers now have reached a point where dependable station heat rate characteristics can be duplicated day after day. Application of the different methods of load division, however, is dependent essentially upon the character of data available. There has been gradual development and transition in varying degrees of accuracy, from the use of average operating performance data on a monthly, weekly, or daily cost per kw-hr. basis to methods which permit of properly combining the economy characteristics of related equipment so that load can be divided on a minute-to-minute basis and full advantage taken of the immediate load conditions of the boiler room, station, or system.

Written especially for ELECTRICAL ENGINEERING, based upon an oral presentation before the Power Group of the New York Section, A. I. E. E., New York, April 9, 1931. Not published in pamphlet form.

With the increased grouping of stations having quite different characteristics and the rapid introduction of new types of equipment, direct and accurate means of load division must be used to secure the best operating economy. In an interconnected group, individual stations do not necessarily follow the characteristic load curves of the system demand. Consequently there is a shifting of load factors and plant factors among the different stations so that the use of average input-output data has lost much of its value from the standpoint of correct load allocation.

Briefly the steps which should be followed in setting up system-operating economies are:

1. To provide the necessary capacity in operation to insure continuity of service throughout the system.

2. To select the necessary equipment for carrying load in the order of its effect on the best *over-all* system economy.

3. To divide the load correctly on the equipment which has been placed in operation.

At least eight methods of load division have been developed, and in a number of cases the different methods, for certain ranges of operation, result in identical loading. These methods are:

1. Average increment loading.
2. Base loading.
3. Valve loading.
4. Best-point loading.
5. Proportional loading.
6. Equal-efficiency loading.
7. Increment of B. t. u. to throttle loading.
8. Increment loading.

In a system where suitable equipment and personnel are available for testing accurately each piece of equipment, information can be obtained which will permit a very accurate analysis of the load-division problem.

To arrive at the correct equipment set-up and then the correct division of load on the equipment placed in operation, the characteristics of each piece of equipment associated with power production must be known. Operating factors based upon the behavior of the equipment under normal operating conditions must be applied. Operating factors, such as the circulating-water temperature, depend partly upon conditions beyond the control of the operating personnel. In most cases, however, proper maintenance and skilful operation will result in close agreement between test and operating results. With individual characteristics known, group and station characteristics may be developed from which the final solutions may be built up.

In combination with the station characteristics, system layout and load data must be taken into account. The major factors which must be considered are: the characteristics of the daily load, load duration, and occurrence curves; local and emergency demands; local restrictive ordinances; tie-line capacities, and experience with the reliability and stability of the electrical system.

With proper equipment available and station charac-

teristics known, not only can a correct solution of any momentary load-division problem be reached, but studies may be projected into the future showing the probable share of load which new equipment would receive, based upon contractual characteristics. The effect of new equipment on operating costs also may be predicted quite accurately. The result of allocating any subdivision of the system load for any station may be computed, and system operating results for any proposed method may be estimated accurately. After the correctness of the station heat-rate characteristics has been established from tests and operating results, these data may be applied to the derivation of instantaneous energy costs which in turn may be used as the energy element of the cost of load transferred from one station or system to another at different periods of the day.

The different methods of load division now will be discussed in approximately the same order named previously. Fig. 1 shows station characteristics taken from daily operating data and illustrates the *average increment* method of loading. Each point represents the integrated 24-hr. output for various station loads plotted against total B. t. u. input. Over a period of time a large number of values are obtained which give the average economy characteristic trend of the station. Straight lines may be drawn through these points as indicated for stations *A* and *B*, and from this information a determination may be made as to how to load the stations with respect to each other. It is evident that if a daily output of only 100,000 kw-hr. is needed, station *A* could carry the load with less input than station *B*; if the output were 400,000 kw-hr., station *B* could carry it more economically than station *A*. If both stations were required to be in operation, station *A* would be operated at its minimum capacity until station *B* was fully loaded; and then station *A* would be loaded. This method of loading in no way takes advantage of the minute-to-minute economy relation between the stations, but merely uses the average integrated characteristics. As a result a constant increment of input is required for any added output and this constant increment represents an average increment characteristic of the station.

The method of *base loading* follows directly from the foregoing as it gives load to the best station or machine up to its maximum capacity before any load beyond its minimum requirements is assigned to the next best station or machine. Within the limits of data available both of these methods are correct, but as will be shown later they do not result in the best economy. It would appear further from a casual inspection of the heat-rate characteristics (see Fig. 6) that the *base-load* method is the correct one; but again this is not the case.

In Fig. 2 is shown a group of heat-rate curves which will be used to explain *valve opening*, *best-point*, and *equal-efficiency* methods of loading. Heat-rate characteristics of the older turbines are such that their best economy is obtained just before the opening of the overload valves which bypass steam into some of the lower stages of the turbine. The points at which these additional valves open are shown rather clearly in the illustration, and their effect will be fully illustrated later in showing the progress made in methods of interpreting turbine characteristics.

In the *valve opening* method when several turbines are in operation, the turbine with the lowest heat rate will be loaded first to the point where the overload valve is about to open. The other turbines then will be brought up successively to a similar condition. As the load increases still further, the best unit will be loaded

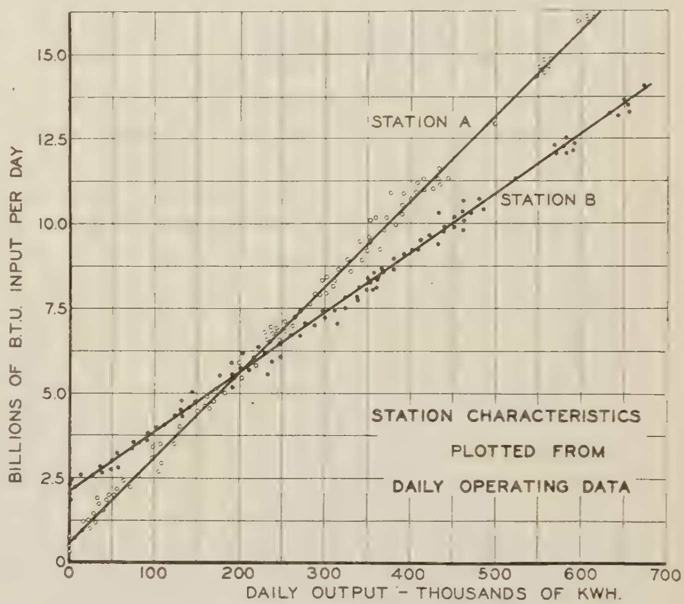

Fig. 1. Average characteristics for two typical stations as obtained from daily operating data

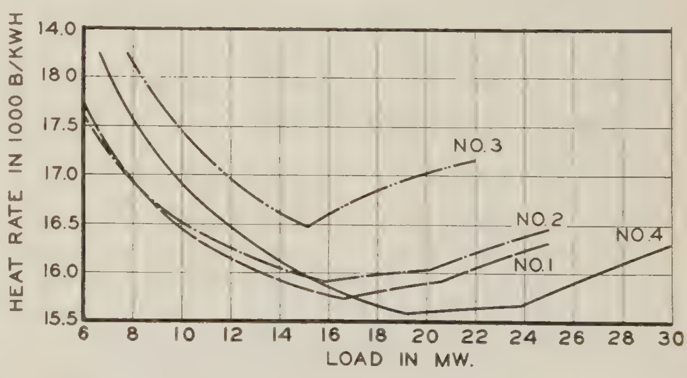

Fig. 2. Heat-rate curves for four typical turbines. Note the changing characteristics at the valve-opening points

up to the next valve opening, and the process repeated on the other units until full load is reached on all equipment in operation.

Best-point loading in effect is quite similar to the *valve-opening* method but applies more generally to the total station heat-rate characteristics which include

also the boilers. With this method, units or stations are loaded successively up to their lowest heat-rate points. In most cases, however, these coincide with the valve-opening points.

In the *equal-efficiency* method, the ratio of output to input of the various turbines must be equal, and in effect the unit heat rates also must be equal. Where this scheme is used, a schedule may be made up by maintaining equal unit heat rates on a variety of turbines, progressively as the load changes.

Fig. 3 shows a graphical layout for the method of *proportional loading*. This consists merely of plotting the sum of the turbine loads at their best heat rates and their full-load points, and connecting these points through zero with straight lines; from these, unit loads can be scaled off for any given station load.

Still another scheme is that known as the *increment of B. t. u. to the throttle* method. This is merely a special case of the incremental method, and has rather limited use where there is no bleed heating and where the characteristics between turbines are uniform.

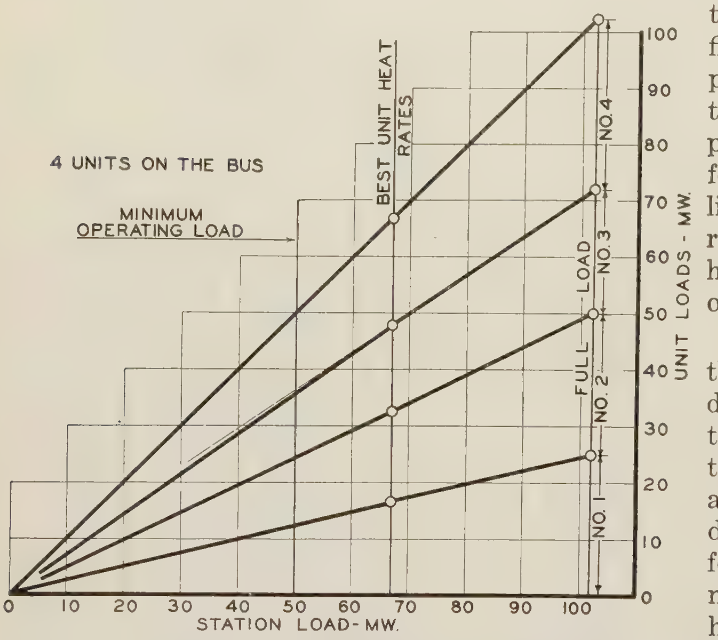

Fig. 3. Curves for establishing a proportional schedule of loading

Incremental loading, as the following discussion will bring out, results in the minimum input for any output with any given combination of equipment in operation. This method will not of itself show what equipment should be placed in operation, but with the aid of input-output data it will assist materially in determining the proper combination of equipment for various system- or station-loading characteristics.

Fig. 4 shows three stages in the chronological development of the interpretation of turbine characteristics and increment rates, the same test information being used in each case. Until about 1920 separate sets of points were plotted for the total input-output and for the unit heat rates, curves being drawn through the two sets of points independently. During the next five years the changing characteristics of the valve points were taken into consideration. As a result, the total input-output curve was drawn through the test points so that straight lines connected the test points for the separate ranges between valve openings. These lines were adjusted, however, to intersect at loads corresponding to the valve openings. The water-rate or heat-rate curves then were computed from the input-output curves.

In a more recent (1930) interpretation of test data the turbines are considered as having separate and distinct characteristics between valve openings. Entirely independent curves have been drawn through the various sets of test points between valve openings, and the unit heat rates computed from these independent sections. The corresponding incremental rates for the three schemes have been plotted and it may be noted that on the 1930 curve, the transition points have not been included on the incremental curve. From a practical standpoint this is not necessary because turbines are not operated near the valve openings,

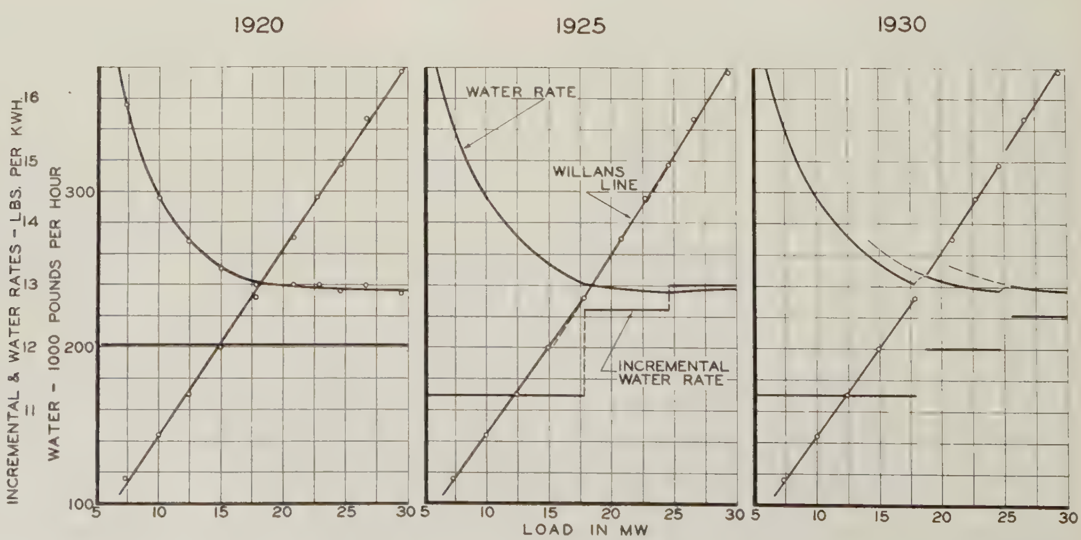

Fig. 4. Chronological development in the interpretation of turbine characteristic data

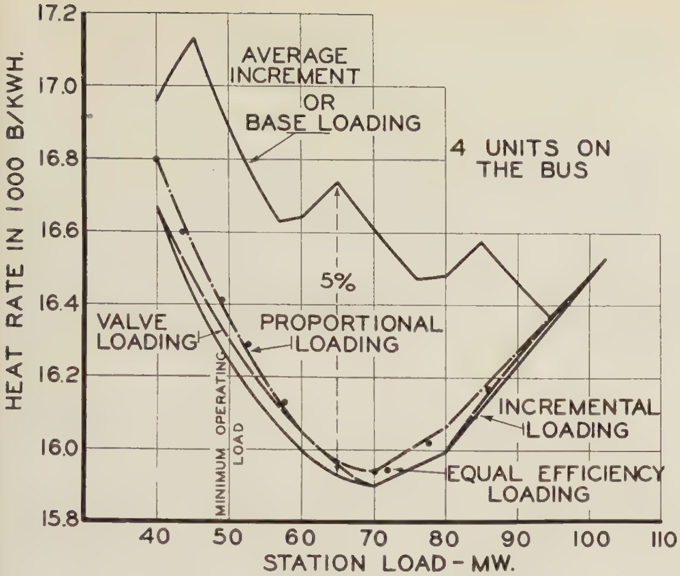

Fig. 5. Comparison of heat rates for the different methods of loading

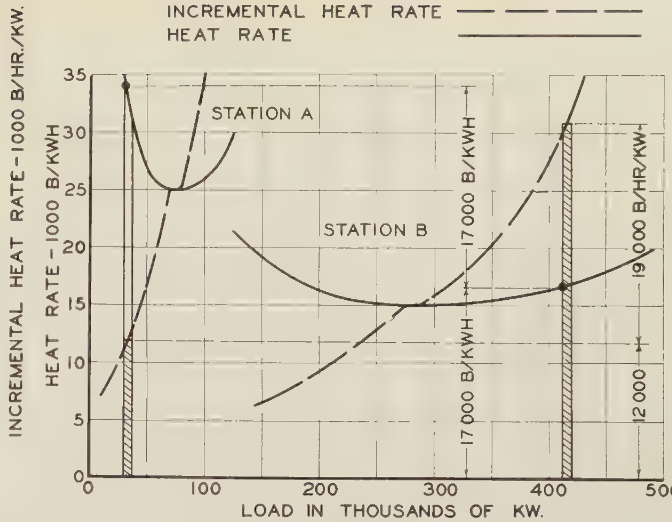

Fig. 6. Solution of typical load-division problem by the increment method

The incremental heat rate at a given load already in production is defined as the actual additional heat per hour required to obtain the added load

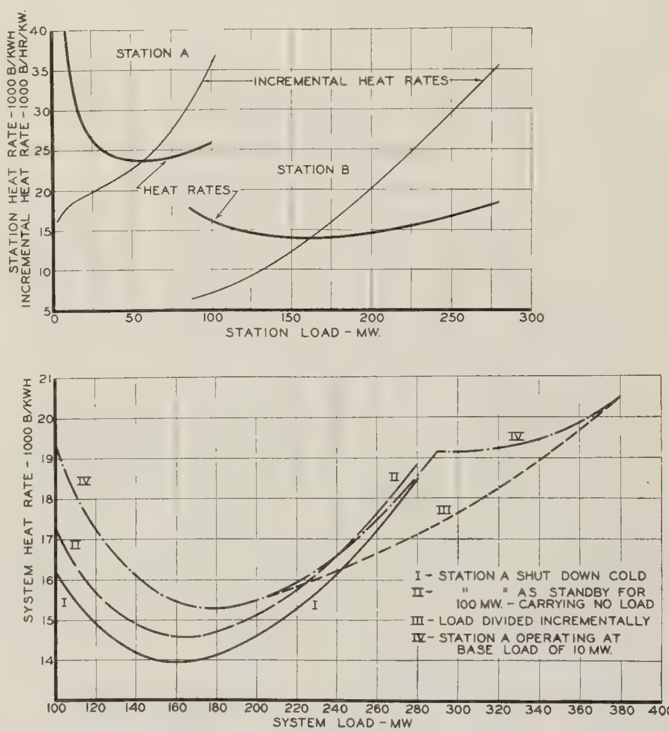

Fig. 7. Four methods of loading two interconnected stations having different heat rates

the operator passing substantially beyond those points. Again, justification for base loading of the best equipment is seen in the method used up to 1920, as a single straight input-output curve with a constant slope or increment is obtained which in itself justifies loading the best equipment or the equipment with the lowest average increment up to full load and then bringing on the next best.

A composite picture of the results of the various methods of load division is shown in Fig. 5. As would be expected the exact incremental method proves the most economical, while the average incremental or base loading method makes the poorest showing. The various other methods fall in between these two but generally nearer the exact incremental method.

The underlying principles of the incremental method are brought out by Fig. 6. Heat rates are indicated for two stations having 10,000 B. t. u. difference between their best points. Assume that the stations are so loaded that the heat rate of station *A* is exactly double that of station *B*. The question now arises as to which station should pick up the next 1,000-kw. load, assuming that the two are interconnected. From the heat-rate curves alone it would appear that station *B* should carry the additional load. It should be noted, however, that the heat rate is on the up-grade at station *B*, so that any added load would mean that its entire load would then be obtained at a higher heat rate and consequently the additional 1,000 kw. must contribute additional heat to raise the over-all heat rate of the station. On the other hand, an examination of the curves will show that the load on station *A* is such that if the added load were allotted to it, every kilowatt already in production would be obtained at a lower heat rate. At the points selected, station *A* can supply the added load to the system for 12,000 B. t. u., whereas station *B* would require 31,000 B. t. u. to produce the same load increment.

It may be noted that the dotted curves corresponding to the incremental heat rates are lower than the average heat rates while the heat rate curves are diminishing; that the incremental and average heat rates coincide where the average heat-rate curve is horizontal; and that the incremental rate is greater when the average is increasing. It can be proved mathematically and actually demonstrated that the most economical

division of load is obtained when the incremental rates are equal.

As an example of a typical loading problem where two stations with different heat-rate characteristics are available, Fig. 7 illustrates the effect on system economy of operating the high-heat-rate station in different ways. Case I assumes that the best station alone is capable of carrying the entire load safely up to its full capacity, with the poorer station shut down cold. Thus if a system load up to 280,000 kw. were carried on station *B* alone, it would follow curve I. In case II it is assumed that station *A* is held with banked boilers, ready for emergency use in the event that station *B* might require emergency assistance. In this case the system heat rate would be represented by curve II. Case III goes one step farther than case II in that station *A* is maintained as a running reserve, with incremental division of load between the two stations. In this case the system heat rate would be as shown by curve III for loads above 2000,000 kw. In case IV station *A* is maintained as a running reserve as in case III, but the load between the two stations is divided by the base loading method. The system heat rate under these conditions would follow curve IV.

An interesting feature of the set of curves shown in Fig. 7 is that for loads above 240,000 kw. the system heat rate is lower with station *A* in operation than with it shut down cold. Should there be an appreciable number of kilowatt-hours to be generated at a system load higher than 240,000 kw., not only would the system be better protected by having station *A* in operation but the actual integrated heat rate would be better, as well as the instantaneous rate.

As supplementary to the foregoing discussion, the curves of Figs. 8, 9, and 10 are presented. Fig. 8 shows the heat-rate characteristics of a station with a given combination of boilers and various combinations of units in operation. For purposes of academic interest an average station heat-rate curve, such as has been used for the two previous demonstrations, is superposed on the group. Fig. 9 indicates the possible widespread variation in station heat rates, particularly of standby stations when the station plant factors and the capacity held available for emergency use are changed arbitrarily. Fig. 10 shows the general range of boiler and turbine characteristics in a large metropolitan district. The numbers opposite each curve represent the number of boilers or turbines observed to have the characteristics shown. For clarity, only a typical curve for each group has been drawn.

Basically, the problem of load division in a metropolitan area is a problem in thermodynamics. Ascertaining the principal characteristics of the equipment under operating conditions has become an extremely refined operation and is in itself a very large subject. The tremendous number of combinations of boilers and turbines which exist in any large interconnected system, the limitations imposed by the electrical system, and the ability of standby stations to be available instantly, make a complete solution extremely intricate. Instruments, however, have been developed to take care of the tremendous number of combinations once

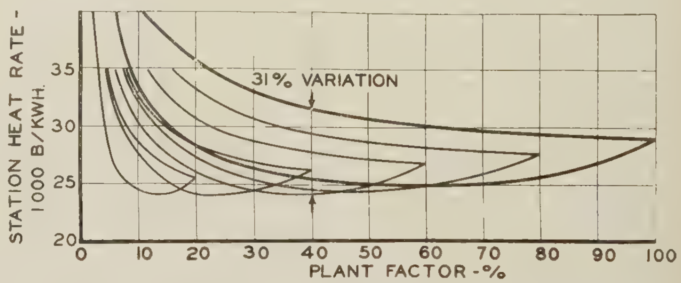

Fig. 9. Effect of peak plant capacity and load factor on station heat rate

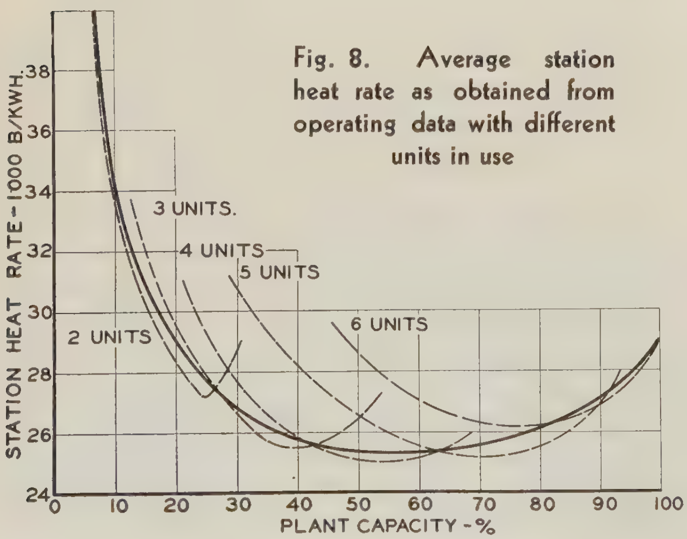

Fig. 8. Average station heat rate as obtained from operating data with different units in use

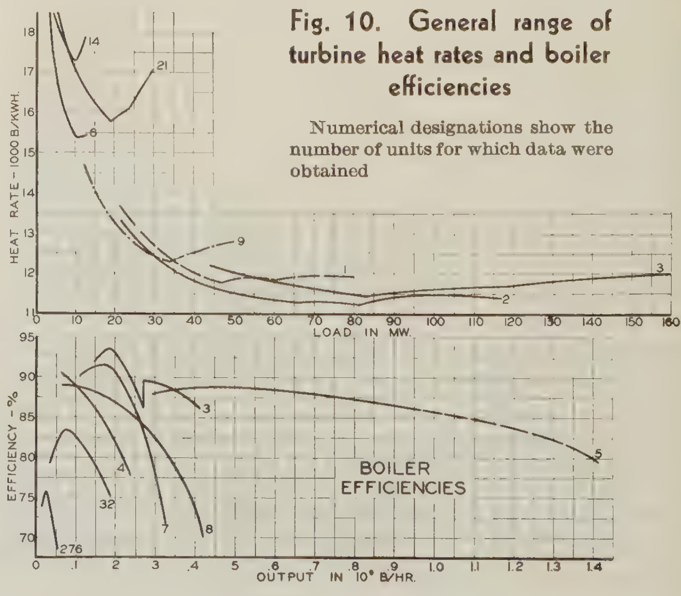

Fig. 10. General range of turbine heat rates and boiler efficiencies

Numerical designations show the number of units for which data were obtained

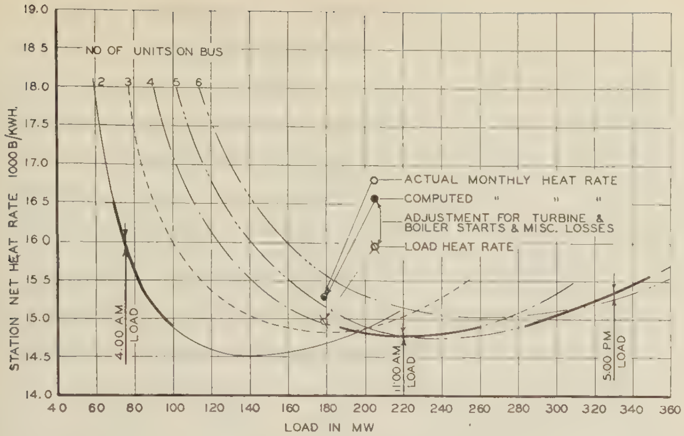

Fig. 11. Comparison between actual system monthly heat rate and computed value

the basic boiler and turbine characteristics have been determined properly.

Both the accuracy of the computations and the operation may be checked as shown in Fig. 11. This gives an illustrative group of station heat-rate curves as computed, and shows the computed monthly heat rate as compared with the actual monthly heat rate. The computed and actual rates may be seen to be practically identical.

By way of summary, the economic loading of generating stations possesses a wide variety of aspects all of which should be studied in order to arrive at a true perspective. The solution must be built up from individual equipment performance data in which the boiler characteristics play the most important part. This is particularly true when comparing two or more separate stations. It has been found also that obtaining accurate equipment characteristics has effects beyond the furnishing of data for load division and the establishing of "bogies" for operation. Manufacturers of large equipment have difficulty in checking their design practises without actual tests, and these can only be run after the equipment has been installed. Thus successive designs and guarantees may be based upon accurate information taken in the field rather than upon theoretical computation and extrapolated estimates. Furthermore, correct operating characteristics permit an estimate to be made of how well the system is being operated with respect to its possibilities, and this in turn gives assurance that no major improvement is being overlooked.

Basically, a load schedule should be set up on the assumption of unlimited tie facilities with no restrictions as to starting up or shutting down equipment. Schedules then should be set up adding successively the elements of safe operation of equipment, continuity of service, restrictive boiler-loading conditions, and tie capacity. In this way the cost of each inhibiting element may be determined. Such evaluations may be continued to take in the addition of new tie capacity, feeders, or station equipment.

The Engineer in Civic Affairs

Some of the features involved in the problem of "establishing a high professional standing of engineers in public affairs" are discussed here. Establishment of state and local engineering councils, and some means of "certification" of engineers by national professional societies are mentioned as steps toward a possible solution.

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THE QUESTION of establishing and maintaining a high professional standing of engineers in civic and other similar affairs is one which requires limitation and definition to bring it within the scope of a single discussion. Three possible interpretations suggest themselves:

1. A complaint against public opinion because engineers' opinions on public questions are not given the respectful attention which engineers think they deserve.

2. A criticism of the engineering profession implying that professional standards are too low to cause engineering opinions on public matters to command public attention and respect.

3. An implication that although the profession and its standards are all right, a technique through which to make the profession authoritatively and effectively articulate on public questions is lacking.

If the first suggested interpretation were the correct one, and the effort were to devise ways and means of convincing the public that engineers should be listened to with greater respect when they deign to speak, I confess that I should have little sympathy with it. The time has passed when the professions had a monopoly on education. Nowadays an opinion on public affairs must run the gauntlet of well-informed persons in all walks of life, and must establish itself through its content rather than through its source.

Therefore, I shall assume that it is the engineering profession rather than the public which is to be scrutinized in this discussion, and that questions of both standards and methods are to be considered. In the subject thus defined there seem to be two questions involved:

1. How to establish a high professional standing of engineers.

A dissertation presented at the conference of officers, delegates, and members held at Asheville, N. C., June 22, 1931, in connection with the annual summer convention of the A. I. E. E. Not published in pamphlet form.

2. How to establish a high standing of the engineering profession in public affairs.

Individual Ideals Must be High

The attributes and responsibilities of these two aspects of professional life are well stated in an article on the "Professional Status of the Engineer" by W. E. Wickenden, president of the Case School of Applied Science (Cleveland) which appeared in the October 1930 issue of *Civil Engineering*. Dr. Wickenden states the following four attributes of individual professional life.

"1. A type of activity marked by high individual responsibility and dealing with problems on a high intellectual plane.

"2. A motive of service, as distinct from profit.

"3. A motive of self-expression which implies a joy in one's work and a single standard of workmanship; one's best.

"4. A conscious recognition of social duty to be accomplished, among other means, by: (a) sharing advances in professional knowledge; (b) guarding the standards and ideals of one's profession, and advancing it in public understanding and esteem; or (c) rendering gratuitous public service in addition to ordinary professional service, as a return for special advantages of education and status."

As a means by which individual engineers may attain a high professional standing I should recommend the conscious recognition and practise of these ideals which thoroughly express what should be the ethical and mental attitude of an engineer.

Group Responsibilities

Doctor Wickenden also states the following as attributes of group professional life:

"1. A body of knowledge (science) and art (skill), held as a common possession and to be extended by united effort.

"2. An educational process of professional aims which implies a constructive share by the professional group in the ordering of education.

"3. A standard of qualifications for admission to the professional group, based on character, training, and competency.

"4. A standard of conduct in relations with clients, colleagues, and the public, based on courtesy, honor, and ethics.

"5. A recognition of status by colleagues or by organized society, as a basis of good standing.

"6. An organization of the professional group, based primarily on common interest and social duty rather than upon economic monopoly (not universal in the artistic professions)."

In addition to the obligation of the engineer to maintain a high professional standing as an individual there appears the obligation or desirability of establishing somehow this "recognition of status . . . . . by organized society" for the engineering group as a whole. Doctor Wickenden ably discussed this subject under the heading of four questions:

"1. Should we seek to divide the profession into distinct strata, or maintain an inclusive form of organization?

"2. Should we look to the public or to ourselves to set up and maintain our professional standards?

"3. Shall we narrow the doors of access to the profession?

"4. Shall we impose more rigid standards upon the colleges?"

The Matter of Organization

Under the first question would seem to come the problem of our own Institute organization. Should we have a single grade of membership or should we maintain the several grades? Much is to be said for the graded membership principle. In this country we have no aristocracy; no peerage. The result has been that for measuring one's attainments in life, no yardstick seems to be left but the financial one, a condition which I believe is largely responsible for the unfortunate American habit of measuring success entirely in terms of dollars and cents. Human beings seem to be possessed of an inherent desire to rise above the "common herd." Of those who fail to satisfy that desire by the acquisition of wealth, many seem to find satisfaction in the fraternal and social organizations with which this country is blessed (or cursed?) and get the satisfaction which they seek by attaining the distinction of election as "Kingfish of the Mystic Knights of the Sea," or perhaps as Fellows of the American Institute of Electrical Engineers. Personally, I believe that this sort of thing is a human necessity. Perhaps the field for its proper exercise is within the bounds of our professional and social organizations rather than in our civic life as a whole, but in my opinion a country which had *no means* of measuring the worth of its citizens other than by a dollar sign would be in a bad way.

Under the second question comes the matter of licensing engineers. In spite of the general opinion of engineers of high standing, that licensing is not the solution of the problem, we not only are facing, but even now are in the midst of the licensing problem. This subject already has been set forth in discussion and will not be treated here.

Under the third item again appears the question of professional society organization. Some have thought that we open our doors too wide and that higher qualifications should be required for admission to any grade of membership in a national engineering society. However, our principles and practises, as a society (A. I. E. E.) are long established in this matter and it appears doubtful that they should be changed at this late date.

Under the fourth question comes the problem of engineering education. While this problem has an important bearing on the broad question of the status of the engineer in the community, it is too large a subject to attempt to interject into this discussion.

Is Certification the Answer?

A solution of the problem of establishing for engineers "recognition of status by organized society" suggested by Doctor Wickenden is "the certification of engineers by our major professional societies." His proposal in this regard is worthy of being quoted in full. He says:

"Specifically, I should like to advocate one measure. It is in no sense a cure-all yet it would help in some degree toward the solution of each of the problems which has been discussed. This measure is the certification of engineers by our major professional societies. I would favor keeping the profession open, not making it a legal monopoly; and I would let licensing laws run their course until they find the level of their inherent limitations. I would keep our membership inclusive and not too rigidly graded, granting to engineers who pass into administrative duties the full fellowship of the profession. I should keep educational doors open to even greater variety, with a minimum of regulation and a maximum of guidance by the organized profession. All this is broad church doctrine in harmony with our history and traditions, and all good as far as it goes. But the profession needs more than an open association of like-minded men; it needs an inner nucleus of highly qualified men whose professional standing and standards the public cannot possibly mistake. A plan of certification by the profession is a task for many men to work out, not one. May I suggest, however, the following features:

"1. Certification should be earned, not granted as a mark of honor.

"2. There should be a code of educational qualifications more advanced than mere graduation from college and yet attainable by both college and non-college men.

"3. These qualifications should be tested individually, not gaged by personal estimates and testimonials alone.

"4. Educational qualifications should comprise scientific, technical, economic, and civic knowledge of a mature order.

"5. There should be a code of experience qualifications which would normally make the age of certification fall between 25 and 30.

"6. The certification of graduates should be the goal toward which the colleges and the professional societies should bend their influence. To this end the colleges should be encouraged to limit the award of professional degrees to those who previously have been certified."

Character Cannot be Inculcated by Statute

Here is a challenge to the engineering societies and the engineering profession as a whole which seems worthy of very careful consideration. It is no easy problem; the setting up of the necessary standards and qualifications for certification will be a long and difficult task, and the administration of the certification machinery after its establishment will call for men of the highest attainments and maturest judgment. And it all will cost money. If, however, the engineering profession decides that the results to be obtained will be worth the effort and cost, this seems to be a solution which would meet the desires and opinions of many of our members. I believe that its attainment, however desirable, is rather remotely in the future. Is there nothing that can be done in the meantime?

As to the licensing of engineers, doubtless some good can be accomplished if licensing laws are properly set up and administered, but as a means of separating the sheep from the goats in the engineering profession, I personally question the efficacy of inflexible statute laws. Character and ability cannot be inculcated by statute.

Is not the immediate problem that of "establishing machinery through which the opinions of competent engineers may be recognized, respected, and made effective in public affairs?"

In an attempt to answer this question, suppose we consider how we ourselves as "laymen" regard the opinions of lawyers, ministers, and others on public questions. In evaluating such an opinion, do we not subject it to critical analysis in the light of our own knowledge and judge it more by its content than by the standing of its authors? Particularly if the subject under consideration is one outside of the author's immediate specialized field.

Therefore an expression of opinion, whether by engineers or others, to be respectfully received by the public must either (1) be confined to a subject on which the author is a recognized authority, or (2) must contain within itself such evidence of breadth of view and sound judgment that it carries its own conviction.

Public Affairs Committees Suggested

Opinions by men of the engineering profession on matters of public interest rarely can be expected to fall in the first of these classes. Whence it would appear that the only way to make respected and effective the opinions of engineers on public questions is to establish some way by which such opinions can be made to bear on their faces the evidence of their own value. How can this be accomplished? How do we accomplish it in our own organization? If we wish to obtain a well considered and seasoned opinion on any engineering subject, standardization for instance, we appoint a representative committee from those best qualified to pass judgment on the matter. This committee meets, discusses, investigates, compromises, and ultimately arrives at a consensus of opinion which, when finally promulgated, is received with respect and usually accepted by the industry. If the engineering profession expects its opinions to be received with respect by the public this same method must be followed.

How, then, should such committees or groups be constituted? Obviously no one professional society can act alone in public matters; cooperation of all seems necessary. A start already has been made through the organization of The Engineering Council, a joint activity of the national engineering societies set up to deal with national affairs.

The next step in a logical development along these lines appear to be the establishment of state engineering councils to deal with engineering problems confined within state boundaries. Some action already has been taken in this direction.

Local Engineering Councils Logical

The third logical step would appear to be the formation of local engineering councils. Such councils already have been established in certain places and some of these are understood to be functioning successfully. Such local councils doubtless at first would have to be confined to the larger centers where local units of the national engineering societies exist, where they can be organized by joint action of such local groups. Possibly later on, means may be found to establish such local councils in smaller communities. To be useful to the community, such local councils should establish some sort of working arrangement with the local governing bodies.

Assuming then that the immediate solution of the problem of making the opinions of engineers respected and effective in public affairs lies in the formation of national, state, and local engineering councils, how can the A. I. E. E. promote the formation of such groups? I advance the following suggestions:

1. By gathering information on existing local and state engineering councils.

2. By establishing a standing committee to promote, oversee, and advise such local councils in cooperation with similar committee in other national societies.

3. By formulating preferred courses of local cooperation between A. I. E. E. Sections and units of other national societies for joint action in local public affairs.

4. By formulating in cooperation with the other societies a code of procedure and ethics to guide local councils.

5. By codifying successful methods of cooperation or contact between local councils and local governing bodies and assisting in establishing such contacts.

In summation, the solution of the problem of "establishing a high professional standing of engineers in civic and other affairs," may be along either or both of two lines:

1. Establishment of state and local engineering councils by joint action of the national engineering societies.

2. Establishing "an inner nucleus of highly qualified men whose professional standing and standards the public cannot possibly mistake" by some method and process of "certification of engineers by our major engineering societies."

Should the second plan ultimately be adopted, the various engineering councils might well be made up exclusively of "certified" engineers. The councils themselves, in all probability, still would be necessary, however. As an immediate step toward the desired end the formation of such councils composed of engineers of recognized high professional standing need not wait for the certification plan to be adopted.

Editor's Note: Correspondence is invited pertaining to any phase of the important subjects touched upon by Mr. Johnson. Every engineer all too soon will find himself the object and subject of inevitable legislation. For the greatest good of all concerned each individual should exert himself in cooperation with his national society to effect the necessary guidance and control of the situation.

Series Resistance To Increase Stability

As a possible method of increasing the transient stability limits of a long transmission system the author discusses the effects of inserting series resistances into the generator circuits to load the machines during fault conditions and thus retard subsequent overswings.

By
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DEMANDS FOR CONTINUITY of power delivery from large electric stations which depend upon long transmission lines have expedited the development of high-speed circuit breakers and relays. Modern equipment will clear a fault with sequential breaker operation in from 8 to 16 cycles, depending upon the proximity of the fault to one end of the line. Because of the relatively low stored-energy-per-kilowatt factor of hydroelectric units and some steam units, even this short time, however, will not prevent loss of synchronism in many cases.

In this discussion consideration is given to the effects that may be achieved by inserting a relatively high series resistance into the generator circuit upon the advent of a short circuit. As an example for descriptive purposes, consider a short circuit to occur very close to [1] on the line [1]-[2] as shown in Fig. 1. The proposed series resistance normally would be short-circuited by circuit breaker [3]. A normal 60-cycle system is assumed; impedances as given on the diagram are based upon generator rating (kw.) and represent typical proportions. To assure that the ratio of resistance percentage to generator rating remains unchanged regardless of the number of machines in service, it is considered that resistances should be connected as shown in Fig. 2.

Upon the occurrence of a three-phase short circuit near circuit breaker [1] the generator electrical output will be decreased instantly from 100 per cent to 12 per cent of rating as a result of the low power factor in the fault-current circuit. The prime mover will continue

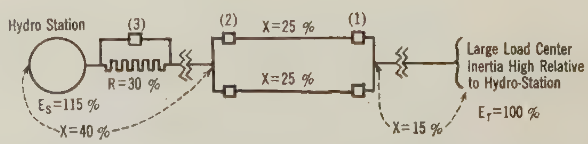

Fig. 1. Schematic diagram of system considered

From "Series Resistance Method of Increasing Transient Stability Limit," (No. 31-39) presented at the A. I. E. E. winter convention, New York, Jan. 26-30, 1931.

to apply 100 per cent torque and the difference of 88 per cent torque will accelerate the rotor. Circuit breaker [3] can be opened in from 5 to 6 cycles to insert the series resistance, and the resulting power loss will increase the generator electrical output from 12 per cent to 105 per cent until circuit breaker [1] opens after 8 cycles. A similar action takes place during the interval from 8 to 16 cycles when the fault is entirely removed from the system by the opening of circuit breaker [2]. The series resistance limits the rotor acceleration to about the same amount as would obtain if the fault were entirely removed in 5 or 6 cycles instead of in 16 cycles. This indicates the possible beneficial effects of loading the generators by inserting series resistance in the circuit during the fault period. After the fault has been cleared, the added series resistance component even though it increases the total circuit impedance exerts a substantial stabilizing influence because the stored energy of the hydro generators is less than that of the load center.

This action is shown in Figs. 3-6. Fig. 4 shows that the series resistance increases the maximum possible generator output from 147 per cent to 188 per cent of rated kilowatts. This is done at the expense of decreasing the maximum received power from 140 per cent to 92 per cent due to the loss in the series resistance. Figs. 5 and 6 show the corresponding power-angle diagrams. The shaded area in Fig. 5 shows the additional retardation area made available by the series resistance for reducing the overswing of the hydro unit. This large retarding force, acting only on the relatively low inertia of the hydro units, permits them to reach the position E_s'' (Fig. 3) instead of the position E_s' 18 cycles after a given fault, making the large gain of a_1 deg. The decreased power delivered to the load center is shown by Fig. 6, but due to the high inertia there as compared to the hydro generators a retardation of only a_2 deg. occurs. At the end of 18 cycles the total angular displacement has been decreased $a_1 - a_2$ deg. as a direct result of the insertion of 30 per cent series resistance in the generator neutral leads.

The series resistance, therefore, is beneficial in maintaining stability both during and after a fault. Even if it is left in the circuit for a considerable time after fault clearance, the only effect will be a decrease in system frequency resulting from the added resistance loss; synchronism will be maintained.

Calculations Checked by Test

For the purpose of checking the methods of calculation used a shop test set-up of proportions similar to the hydroelectric transmission system of Fig. 1 was made. The hydro station was represented by a 100-kva. synchronous motor-generator set with the d-c. end acting as a prime mover. Sufficient external resistance was used in series with the motor armature to give it approximately constant-torque characteristics over a sufficient range of speed. The tests showed that for the same fault and time of circuit breaker operation, more than 50 per cent additional power could be delivered through the use of the series resistance without loss of synchronism.

For a system where the synchronous equipment at

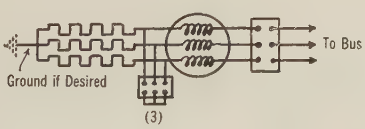

Fig. 2. Preferred location of series resistors

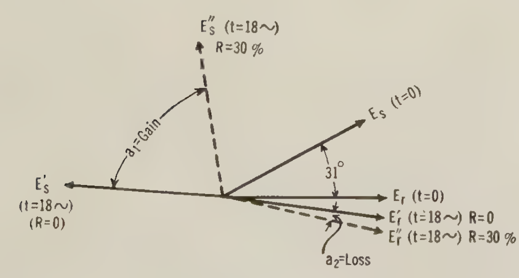

Fig. 3. Vector positions 18 cycles after fault

Angle between E_S and E_r decreased by series resistance. Low-inertia generators retarded at greater rate than high-inertia load center

Effect of 30 per cent series resistance upon system of Fig. 1 during single-line operation after fault has been cleared

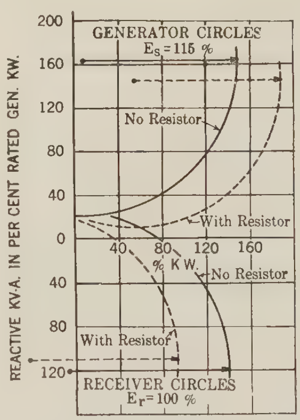

Fig. 4. Circle diagrams for single-line service

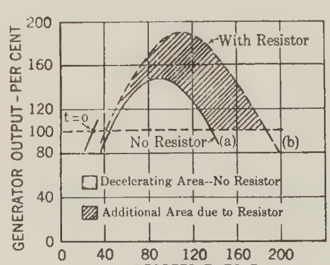

Fig. 5. Generator power-angle diagram

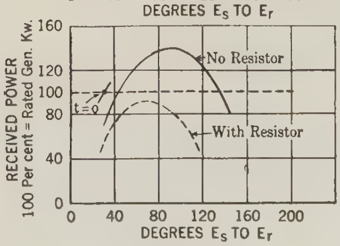

Fig. 6. Receiver power-angle diagram

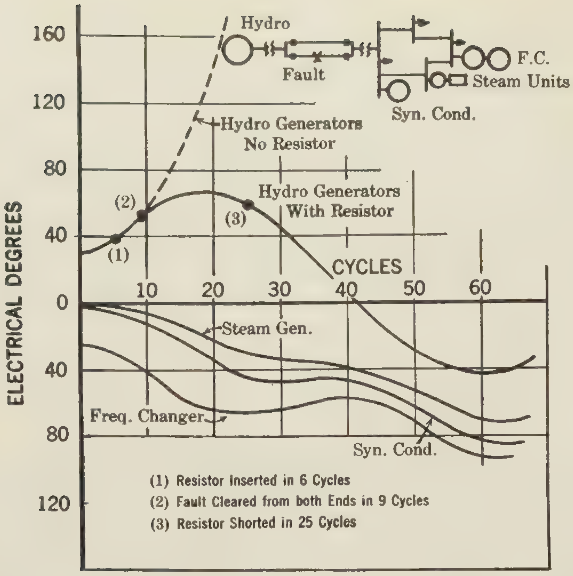

Fig. 7. Transients on typical system showing effect of series resistance

the load-end is smaller in proportion to the hydro station than usually is the case, angular oscillations obtained from a point-by-point calculation with the help of an a-c. calculating board are shown in Fig. 7. There the dotted line indicates the rapidity with which the hydro generators go out of synchronism as compared to the characteristics of the synchronous machines at the load-end, if no series resistance is inserted. The full lines show the angular oscillation with 30 per cent series resistance inserted in the circuit during the period from 6 to 25 cycles following the fault. It is evident that synchronism will be maintained, because the angular deviation has been restored to about normal within 60 cycles and the system will stabilize itself after a few oscillations. The downward slope of the curve indicates that the system frequency has decreased slightly as the result of losses occurring while the series resistance was in the circuit. The slight decrease in frequency, however, is of no consequence so long as synchronism is maintained.

The magnitude of the series resistance can be varied over a wide range with practically the same results; in any event it should be inserted as soon as possible after the fault occurs. The length of time that it is left in the circuit will depend upon the individual system under consideration. The physical size of the resistor is approximately the same as that of a corresponding neutral resistor that would be used with a generator of the rating under consideration.

Conclusion

As indicated, it is believed that by inserting series resistance in the circuit for a short time, synchronism can be maintained readily on a hydro system of normal proportions and for any type of fault, with the speeds of circuit breaker and relay operation now available. The cost of the series resistance and its circuit breaker in general will be less than the combination of other measures that have been used and considered in the past. Unlike most of the other measures for improving stability, the resistor installation can be deferred until operating experience indicates that the added expenditure to maintain service is justified.

Calculations for Inclined Catenary

A method is outlined whereby the vertical and horizontal projections of contact-wire hangers are computed separately and the hanger lengths in turn obtained from these. The method postulates a smooth horizontal curve of contact wire, and can be used for both regular and irregular curves.

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INCLINED CATENARY on curves of railway overhead contact systems is used now quite generally in the United States on systems having a single contact wire, whether simple or compound catenary. An analysis of some of the problems in the design of inclined catenary is presented here outlining a fairly simple and direct method of solving them.

Design of inclined catenary for curves is not so simple as the design of tangent catenary. On regular curves of uniform span length the hangers on each different degree of curve will have different lengths and angles, but standard hangers can easily be calculated for each different degree. On transitions from tangent to regular curves or on sections of track where the degree of curve is continually varying, a separate set of hangers must be calculated for each span.

Forces acting in the catenary system are analyzed by considering separately the vertical and horizontal projections of the wires and hangers. For a horizontal-contact wire if the vertical projection of the shortest

From "Inclined-Catenary Calculations," (No. 31-27) presented at the A. I. E. E. winter convention, New York, Jan. 26-30, 1931.

curve hanger is made equal to the length of the shortest tangent hanger, the vertical projection of the inclined catenary will be the same as the vertical projection of the tangent catenary for a span of the same length. Consequently, all vertical dimensions can be calculated as if dealing with tangent construction.

Horizontal dimensions can be found when the curve of the contact wire with reference to an axis between it and the messenger projection is determined (see Fig. 1). The general relationship between any three adjacent contact-wire ordinates, which determines the shape the contact wire must assume in order to be horizontal is given by the following formula:

$$t_{n-1} = t_n [\,2 + c/(1 + x^2/c_1)\,] - t_{n-1}$$

where $c = s\,w\,(M + T)/v_0\,T\,M$
$c_1 = 2\,v_0\,M/W$
M = messenger tension in lb.
T = contact-wire tension in lb.
W = weight of system in lb. per ft.
s = distance between hangers in ft.
w = weight of s ft. of contact wire in lb.
v_0 = vertical projection of shortest hanger in ft.
x = distance of nth hanger from center of span in ft., measured along axis.
Other relations are as shown in Fig. 2.

From this equation general shape curves can be drawn for any given catenary system. These are called the U and the S curves and are shown in Fig. 3. The U curve corresponds to the shape the contact wire will take on a constant radius track curve. The S curve corresponds to the shape the contact wire will assume on a reverse curve where the reversal occurs at the center of the span. Shapes of the contact wire for curves between these two extreme types can be found by adding together the two curves. The specific shape the wire will take on any given curve is determined by finding the correct multiplier for the U and S curves; thus a general equation may be written,

$$t = a\,U + b\,S$$

where a and b are the respective multipliers of U and S curves to satisfy the conditions of the particular curve in hand. In the case of uniform curves where the span lengths do not change, b becomes zero and a is determined by the length of span, the radius of track curve and the slope of the U curve at the support.

The contact wire must take a smooth continuous curve from span to span. Mathematically this means that the contact wire curves for two adjacent spans must have a common tangent at the support. This is one of the conditions used in the solution of the constants for the general equation of the contact-wire curve. These constants are obtained by solving simultaneously the group of equations which can be written for two adjacent spans. The data regarding the track characteristics are obtained from field measurements or track plans. In order to obtain a solution it is necessary to approximate a value for the contact wire ordinate at the third support in the two spans but it can be done by treating the section of track, at the third support, as a uniform curve. The value used will be checked automatically by the calculations for the next span. When the constants for the general equation are obtained the values for the contact wire ordinates at the various hanger locations and supports can be calculated and all the values for hanger lengths, angles and support locations are known.

The contact-wire curve may not assume the same shape as the track curve. On uniform curves it can be given practically the same shape as the track curve but this imposes certain limitations on the design that are not always desirable. The average unit stresses in the supporting and supported wires must be the same for materials of the same specific gravity. Where this design condition is not followed the contact-wire curve will depart somewhat from the track curve and must be allowed for in the design.

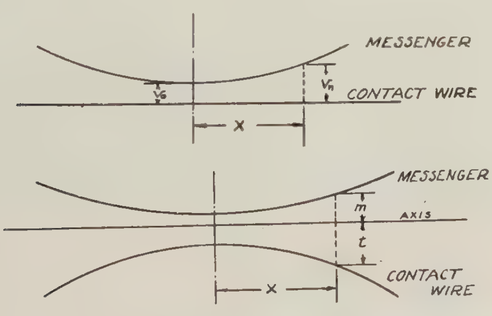

Fig. 1. Vertical (above) and horizontal (below) projections of messenger and contact wire on inclined catenary

The axis between the horizontal projections is established so that $t/m = M/T$, where M and T are the respective tensions in the messenger and contact wires

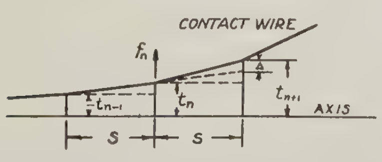

Fig. 2. Horizontal projections of three adjacent hanger locations at any place in the span

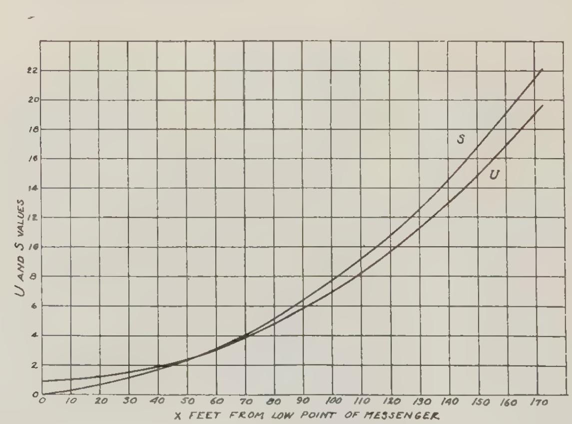

Fig. 3. "U" and "S" curves showing relative horizontal projections of hangers at different points in the span. Values for one-half of the span only are shown, the other half being symmetrical

Catenary Construction for the Cleveland Terminal

Design and construction details involved in the electrification of 59 track miles in connection with a major union terminal development are outlined.

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HEAVY CURRENTS and low overhead clearances were the principal factors governing the design of the catenary system of the Cleveland Union Terminal at Cleveland, Ohio, where twenty 200-ton electric locomotives are in active service, each capable of pulling a fifteen-car pullman train up the maximum grade. Throughout the electrified system were many overhead bridges having relatively low clearance, and most of the station area is covered by buildings with an overhead clearance of but 17.5 ft.

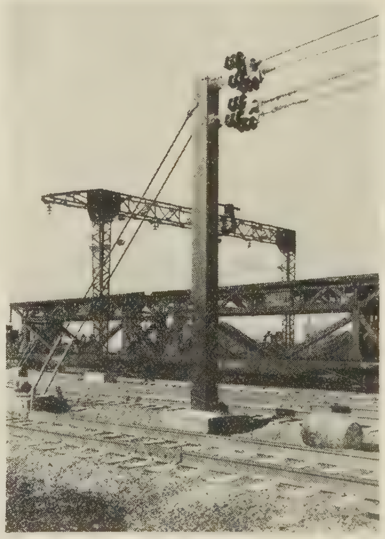
Two main tracks were electrified for a distance of 11 mi. east of the public square, where the station is located, and about 6 mi. west of the same point. Including crossovers and yard tracks, the total electrified mileage is about 59 mi. Two substations, each approximately midway between an end of the electrification and the Cleveland station, supply the catenary system with 3,000 volts direct current.

Catenary Construction

The tangent chord type of construction is used, because the weighty system necessary for the carrying of heavy currents does not lend itself readily to the inclined type of construction. Except through the Cleveland station, the construction over the two main tracks consists of a primary messenger supporting by hangers a secondary or auxiliary messenger to which are clipped two 4/0 grooved bronze contact wires placed side by side. The primary messenger has a 19-wire core of high-strength bronze, and a 16-wire outer layer of copper, the total conductivity being equal to 350,000 cir. mils of copper. The auxiliary messenger is 4/0, 19-wire hard-drawn copper, and the hangers supporting it are of No. 1 hard-drawn copper wire.

For yards and crossovers the auxiliary messenger is dispensed with. The two 4/0 grooved bronze contact wires are placed one above the other, the upper one suspended by means of hangers from a ⅝-in. bronze messenger, and in turn supporting the lower one by clips.

In the station area, tandem contact wires only are used. These are 4/0 grooved bronze wires, one above the other as in yard construction, suspended in approximately 70-ft. spans. This construction was necessary to keep the line down to around 17 ft. above the rail. The main messenger and auxiliary are dead-ended on both sides of the station, and one 150,000-cir. mil cable for each main line track is carried through a duct from one dead end to the other.



Dead-end construction for two main-line catenaries. Yoke assemblies are used for the auxiliary messenger and contact wires, similar to those for the main messenger

Each main line catenary is divided electrically into five sections by four air-gaps or isolated sections. Separate feeders are run to the isolated sections, two sections being on the east and two on the west of the Cleveland station.

The maximum span on tangent track was fixed at 300 ft., giving a sag of approximately 5 ft. at 60 deg. fahr. with the assumed weights. With a 21-in. suspension assembly, a 6-in. center hanger, and an assumed 3-in. distance between the auxiliary messenger and the contact wires, it was found that structures about 7 ft. 6 in. higher than the contact wires were required. Due to the great number of low-clearance overhead street bridges it was decided to use the rather low normal contact wire height of 18 ft. 6 in. at 60 deg. fahr., thus giving a structure height of 26 ft. for a 300-ft. span.

For spacing structures on curves, charts similar to those used by the designers of the Illinois Central catenary system were made up. It was assumed that on curves the contact wire would not be allowed to be more than 12 in. from the inclined center line of the

From "Design of Catenary System for Cleveland Union Terminal," (No. 31-51) presented at the A. I. E. E. winter convention, New York, Jan. 26-30, 1931.

track, either at the center line of the span or at the ends, thus giving a maximum allowable middle ordinate of 2 ft. In laying out the plans, celluloid curves representing the messenger wires with dead load at 0 deg., at 60 deg., and at 120 deg. fahr. were made and used on profile paper to draw in the messenger above the contact wires. The height of all structures then could be read directly from the profile.

When approaching low-clearance overhead street bridges the line was gradually lowered so that the messenger took its natural curve under the bridge, avoiding upthrust on the suspension insulators attached to the bridge. The natural curve used in these cases was the 0-deg. curve.

The various structure heights obtained from the profile were grouped in steps varying by 6 in.; foundation depths also were varied by 6-in. steps. This expediency permitted the structures to be designed in groups varying in height by 1 ft.

Sag and Tension Calculations

Parabolic formulas were used in the sag and tension calculations, because the parabola of the simple curves was considered to give the closest approximation to the true curve of the messenger. The sag and tension chart was drawn for a 300-ft. span, modified slightly from the A. E. R. E. A. chart in that the load lines were made curved instead of straight, thus allowing the use of a uniform scale for sag. The decision to use a non-corrosive messenger was found to introduce large vertical movement that could not be avoided. The messenger finally selected had a sag of 46.5 in. at 0 deg., 58.5 in. at 60 deg., and 73 in. at 120 deg. fahr. for a 300-ft. span.

Steady arms are used on tangent track to brace the auxiliary messenger and contact wires

The equivalent span, using Idail's formula, was found to be 260 ft. for the main line and to range from 120 to 280 ft. for the yard lines. As it was impossible to string every yard line on a different tension basis, the yard-line values were divided into two sets, those having equivalent span lengths up to 200 ft. using 160 ft., and from 200 ft. up using 240 ft. The equivalent span for the auxiliary messenger and contact wires was 20 ft.

From the charts based on equivalent span lengths, curves of tension against temperature were plotted. These stringing charts were made up for all wires. The main messenger chart also had curves of sag against temperature, so that the messenger could be strung by either the sag-stick or the dynamometer method.

The system of spacing hangers which was worked out is simple, looks well, and was easy to lay out in the field. The end hanger is always 10 ft. from the suspension clamp; then, working toward the center, there are as many 20-ft. spaces on each side of the center as will go in evenly. Any space left in the center of the span is divided into from one to three equal spaces. An instrument designed to roll along the messenger was used to mark the spaces so that tapes were not needed. Hanger lengths were obtained to the nearest half-inch by a graphical method.

Structural Details

For dead-ending the main messenger the yoke set used comprises two parallel strings, each consisting of three 10-in. 18,000-lb. insulators. The auxiliary messenger and the two contact wires are dead-ended with a similar assembly giving a symmetrical appearance and equivalent electrical strength. The dead-end assembly for the yard messenger and the two contact wires consists of two 12-in. 24,000-lb. insulators in series.

At all structures on tangent track a steadyarm is used to brace the auxiliary messenger wire and both contact wires. At those structures which were followed immediately by a curve or spiral, a pull-off attachment added to the steadyarm was necessary because of the low auxiliary-messenger tension. If the contact wires are not held where slight changes in alinement occur, such as at the beginning of a spiral, they pull toward the inside of the curve enough to permit the auxiliary

The type of pull-off construction used on the main lines. Much time was saved in construction by the use of chain supports

messenger to gather slack from both sides of the steady-arm resulting in a large horizontal sag in the messenger at the point where it is clamped by the steady arm. On the sharper curves regular pull-offs without steady arms were used.

An interesting feature of this installation is the use of ⅜-in. galvanized chains instead of cable and Crosby clips to hold the pull-off. Much time was saved in erection, and it is expected that by this scheme much more will be saved in maintenance. The chain link is dropped into a slot in the vertical leg of an angle, which in turn is bolted to the column or bracket.

The steadyarms were attached to the structures so as to be approximately horizontal at 0 deg. fahr., and the pull-offs, so that their slope at 0 deg. would be parallel to a line across the top of the track rails. Nearly all the brackets, angles, etc., for supporting the catenary and holding it in the correct horizontal relation to the track are fastened to the structures with bolts to facilitate shifting them to conform with changes in track alinement. The steadyarm and pull-off attachments are designed to permit a vertical adjustment of 1 ft.

After the erection was completed a final alinement of the overhead system was made, using the pantagraph of a trolley as a guide. The pantagraph was marked with white lines 1 ft. on each side of the center, and the catenary was so adjusted that the contact wires were kept within these lines at all points. It was found that very little realinement was needed. No major operating troubles have developed during the several months that this catenary system has been in service; and it has proved very satisfactory.

Telephone Toll Cable Extended

Completion of the longest telephone toll cable west of the Mississippi gives San Francisco and Los Angeles a 275-circuit all-cable communication channel, the equivalent of three of the latest-type 60-wire open leads completely equipped with carrier systems. The project cost ten million dollars, involved some heavy construction problems, and provided an important step toward an ultimate all-cable transcontinental system.

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IN THE TERRITORY of the Pacific Telephone and Telegraph Company there are four major centers of population: the triangle formed by Portland, Seattle, and Spokane on the north; the San Francisco Bay district in the center; the Los Angeles-San Diego area on the south; and the Sacramento-San Joaquin Valley area in the central part of California. Originally, telephone service was established between these centers by the use of relatively small open-wire leads. As demands for intercity service increased, it became necessary to concentrate more plant in the vicinity of these populous areas and also to enlarge the connecting routes.

About 1920 it became apparent that in several cases future telephone facilities would have to be provided by means of cable. Hence a program was entered into initially involving cable extensions from Los Angeles to Long Beach, Anaheim, and Santa Monica; a cable between San Francisco and San Jose; and between Seattle and Tacoma.

Prior to the installation of the San Francisco-Los Angeles toll cable there were two main open-wire toll routes (Fig. 1) between these points, one known as the coast route and the other as the inland route. These leads were of the phantomed type and were transposed for the use of carrier telephone systems. In addition to the voice circuits supplied by these facilities, they provided for miscellaneous services, such as telegraph, radio program supply, and picture transmission. Annual growth in the telephone circuits was such that after 1930 it was economically impossible to care for the requirements by additions to these leads.

Various plans for relief were studied, resulting in 1926 in the adoption of a program for the installation of a toll cable along the inland route. This cable, now completed, is the longest (412 mi.) west of the Mississippi; with buildings and associated equipment, it represents an investment of approximately $10,000,000. It was placed in service September 2, 1930, and provides approximately 275 circuits, about the equivalent of three of the latest type six-arm pole leads fully equipped with carrier telephone systems. Conductors suitable

From "The San Francisco-Los Angeles Section of the Pacific Coast Cable Network," (No. 31-125) presented at the A. I. E. E. Pacific Coast convention, Lake Tahoe, California, Aug. 25-28, 1931.

for both long- and short-haul circuits are included in the cable (Fig. 2) and means are available for furnishing all special services previously mentioned.

Fig. 1. Map showing open-wire and cable routes between San Francisco and Los Angeles

The cable selected was a full-size Bell System standard weighing approximately 7.6 lb. per ft. and having a lead-antimony sheath 0.125 in. thick. In this cable spirally wrapped paper-insulated wires are twisted together to form pairs which in turn are twisted together in groups of two pairs to form "quads," the unit dealt with when it is desired to use phantomed operation to enable three voice paths to be derived from two pairs of wires.

To decrease the attenuation or transmission loss, loading coils in cast iron or welded steel cases are associated with each pair at regular intervals throughout the route. Three Bell Standard loading systems were selected. One (known as H-44-25) is used for long-haul service and consists of 44-mh. coils on sides and 24-mh. coils on phantoms, these coils being placed on *H* or 6,000-ft. spacings. This loading is placed on 19-gage wire and the facilities so obtained are operated on a four-wire basis (*i. e.*, separate paths for the two directions of transmission). Having separate paths for transmitting in two directions makes greater amplification possible at repeater offices and greater freedom from difficulties arising from electrical reflection or echoes. However, with the longer four-wire circuits it still is desirable to install equipment which eliminates the echo return path. Hence echo suppressors are installed at Fresno.

The next loading system, in order of decreasing excellence, consists of the same weight of coils with the same spacing on 16-gage wire, the actual loading differing only in slight adjustments for cross-talk. These

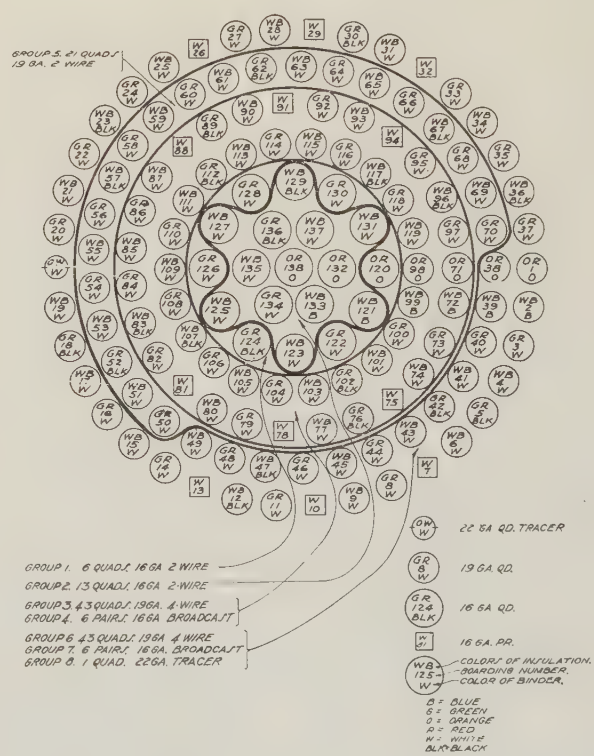

Fig. 2. Typical cross-section of Fresno-Los Angeles unit of new toll cable

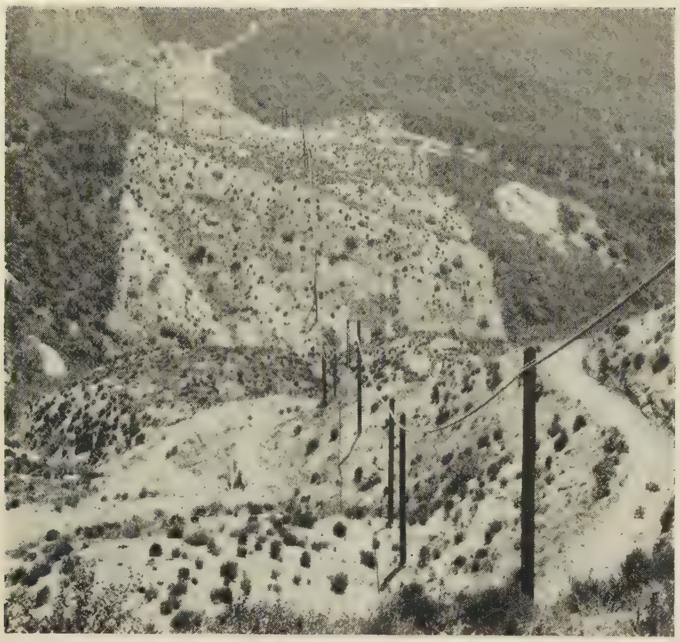

Fig. 3. Cable construction adjacent to old open-wire lead through Tehachapi Mountains

Full-treated 25-ft. Douglas fir poles on 110-ft. spans are normal, although pole heights run to 60 ft. and spans to 510 ft.

facilities are used on a two-wire basis (*i. e.*, the same path for the two directions of transmission). The third system of loading, which has been used on either 16- or 19-gage wires, provides circuits for relatively short hauls only. This system of loading (known as the H-172-63) uses 172- and 63-mh. coils on the sides and phantoms, respectively, placed on 6,000-ft. spacings. A fourth loading system (B-22) not yet in place is proposed for very high-grade service in transmitting radio broadcast programs. This loading is placed on 16-gage pairs and consists of 22-mh. coils placed at 3,000-ft. intervals.

While loading decreases the attenuation of the voice current, amplification still is required at certain intervals on the longer cable circuits. This is obtained by using vacuum-tube amplifiers or "repeaters" more or less regularly spaced along the cable. The practical limit in improvements obtainable by loading, and the lower cost of relatively small wires, made economical the placement of repeaters at about 50-mi. intervals on the Los Angeles-San Francisco cable. There are three types of these repeaters which have been standardized: the first is the four-wire amplifier consisting of two independent amplifiers for the two directions of transmissions; the second is for two-wire circuits and consists of two one-way amplifiers interconnected through devices known as hybrid coils which separate the two directions of transmission; and the third type is for use on the 16-gage B-22 loaded circuits transmitting programs for radio purposes. These are high-quality amplifiers passing a very wide range of frequencies and are used for transmitting in one direction only. The shortness of the spacing between the repeater points at San Francisco and Oakland was justified for practical and economical reasons in connection with 22-gage cable in the submarine section. (Fig. 1.)

As a general rule 20-cycle current is used for signaling on the shorter cable circuits on which telegraph circuits are not superposed. For circuits more than two repeater-sections in length, 135- or 1,000-cycle signaling currents are used, depending upon the economies of the particular case. If 1,000-cycle signaling is used, it is interrupted at the rate of 20 cycles per sec., and has the advantage of passing through and being amplified by the repeaters, necessitating no equipment for relaying around the repeaters as is the case for 20- and 135-cycle current on circuits more than two repeater-sections in length.

Cable Selection and Description

Individual circuits in the cables are designed to provide a predetermined grade of transmission on the basis of the "general toll switching plan," the fundamental Bell System circuit arrangement used for the layout of toll plant. In instances where more than one design will fulfil the requirements the most economical one is selected.

Although it is generally desirable to install a cable with the same make-up in all sections, it was not possible in this case, because of differences in the circuit requirements and the different rates of growth along the various portions of the route. A typical cross-section of the cable used between Fresno and Los Angeles is shown in Fig. 2 where may be noted the location of the various quads and pairs contained in it, the coloring of the insulation which enables particular quads to be identified, and the system of numbering. The quads are arranged in layer formation with the 16-gage quads in the center. The twelve 16-gage broadcast pairs and the 22-gage tracer quad are interspersed in the first and third layers (counting from the outside) of 19-gage quads placed around the 16-gage section. The heavy lines are merely to aid in visualizing the segregation of the various groups in the cable and do not represent a shield or separator of any kind. The tracer quad is used for test pairs during the construction period, and for making good any bad quad in a reel length.

The cable line comprises 138 mi. of aerial cable, 270 mi. of underground cable, and, under San Francisco Bay, 4 mi. of submarine cable. To a great extent location of the aerial plant was dependent upon the terrain and the presence of high-voltage power systems. Private right-of-way routes were available in many sections and where used provide a strip of land at least 100 ft. wide. In general the cable was placed in underground conduit in principal cities and towns, and in such other places as major moves apparently would be required in the immediate future, or where, for other reasons, such construction was economical. With the exception of 18.6 mi. of fiber duct on private right-of-way south of Bakersfield, all of the underground was of

clay duct. The principal sections of the route on private rights-of-way occurred between Hayward and Stockton Junction and between Bakersfield and Newhall; mountainous country was encountered in both instances, justifying the use of private rights-of-way on the basis of savings in cable mileage.

For a distance of some 34 mi. between Merced and Madera the cable parallels an 11-kv. circuit of the San Joaquin Light and Power Corporation at a separation of about 150 ft. This exposure was considered sufficiently severe to warrant some remedial measure, and a plan was developed jointly with the power company which provided for the breaking of the exposure into several sections, and the reduction of its total length by rerouting a portion of the power line. The costs of this measure were borne jointly by the two companies.

For 57 mi. between Bakersfield and Newhall the cable is carried aerially on a private right-of-way. Thirty-five miles of this is over the Tehachapi and Sierra de La Liebre Mountains, passing through some rough country. (Fig. 3.) The route was selected to be as short and direct as possible, consistent with accessibility and economy. The most desirable location leading through fairly direct canyons and passes had to be avoided because of the presence of a 220-kv. power line from which a maximum separation was desirable to avoid inductive interference. The Ridge Route highway, a scenic motor artery which in general follows the summits of the ridges, also was impracticable because of the length of its circuitous route. In these mountains elevations of 4,500 ft. are encountered where heavy snows and occasional sleet storms occur during the winter months. Hence, in accordance with Bell System standards, this section is classified as a medium-loaded area.

Among the unusually interesting construction problems encountered in this 35-mi. desolate and practically uninhabitated section were the building of about 10 mi. of construction road and nine bridges, and the widening and grading of 9 mi. of existing narrow dirt roads or paths. The nearest railroad station from which material could be hauled was Lancaster, on the Mojave desert to the east. From that point a satisfactory road extended for about 40 mi. toward the line from which point special transportation equipment was used over the construction roads. From the railroad delivery point at Lancaster, the principal items of material were transported to the job in a series of three steps: (1) 10-ton six-wheel trucks and trailers hauled the material over as much of the distance as was accessible to them; (2) then 2½-ton four-wheel-drive trucks, and (3) in some instances tractors and trailers, were used to deliver the material to its point of use.

Loading-coil cases weighing as much as 1,675 lb. were placed approximately 6,000 ft. apart and to facilitate this work and the setting of poles, special rigging often was required. Special automotive equipment for handling the reels of cable weighing up to 6,000 lb. and for digging holes, setting poles, and pulling cable was used to good advantage. Frequently because of the ruggedness of the territory and the consequent impossibility of reaching the desired locations with power equipment many of these operations had to be performed by hand.

Fig. 4. Colony built for Quail repeater station

Fig. 5. A piece of typically difficult construction—lowering a reel of cable down a mountain side

Protective Features

The insulating qualities of the paper strip used for electrical separation of the conductors of a telephone cable are entirely dependent upon the exclusion of moisture. For this reason it is essential that the cable sheath be made moisture-proof and maintained in that condition. Methods which have proved valuable during the past few years make use of dry, compressed nitrogen gas, maintained under pressure within the cable sheath. A recent development is the use of continuous pressure in the cable after completion, with low-pressure alarm contactors spaced along the sheath at equal intervals. A drop in pressure in the vicinity of a contactor causes it to operate and close an alarm circuit in the cable which in turn sounds an alarm in the testing office. Gas escaping through any holes occurring in the sheath prevents the entrance of moisture for a sufficient time to permit the hole to be located and repaired. This method is in use in the fiber-duct section south of Bakersfield. The gas outfits consist of 100-cu. ft. tanks equipped with small regulating outfits which control the admission of the gas to the cable.

In general, on this job, each reel of cable was tested by injecting the gas into it under pressure after it had

been pulled into place and before the sheath-ends were opened preparatory to splicing. With a pressure of 12 lb. per sq. in. throughout the cable length, any sheath opening manifested itself by a drop in pressure and was located with the aid of the hissing noise caused by the escaping gas. After each splice was completed it was tested by forcing nitrogen under pressure into it through a small hole in the sleeve, any opening being indicated by bubbles in the liquid soap with which the sleeve then was painted.

Elaborate means are taken in modern toll cables to reduce cross-talk between pairs and to reduce the picking up of noise from outside sources. The various circuit groups are kept separate, each group retaining its identity throughout each repeater section. An example of this is shown in Fig. 2 where it may be seen that the four-wire group transmitting in one direction (Group 6) is kept apart as much as possible from the four-wire group transmitting in the other direction (Group 3). The broadcast pairs are located in the four-wire group transmitting in the same direction in which they are used.

The twisted-pair and quad arrangement previously described provides the initial transposing between circuits. In manufacturing the cable, three regular types of quads are made, each differing from the other by the length required for the pair-twists, and by the length used per twist when the pairs are formed into quads. These different types of quads are used further to reduce the cross-talk between the cable circuits. To avoid the possibility of two quads in adjacent layers continuing beside each other for any particular distance, alternate layers are stranded in opposite directions during manufacture, the exact relationship between the layers shown in Fig. 2 being true only at exceptional points.

Special attention to splicing technique and splice transpositions tends to equalize or compensate for various circuit inequalities, cutting down cross-talk. Further to reduce cross-talk between two-wire circuits, at each repeater point the cross-connections are so arranged that while the phantom circuits are connected straight through, the side circuits are systematically rearranged among the quads. For the four-wire circuits a similar procedure is followed at the repeater offices which are located at the ends of circuit units. It should be noted that all these efforts to reduce the cross-talk do not result in its entire elimination, but serve to reduce it to within an acceptable limit.

Measurements and tests made on the sides and phantoms (after all the splices for a repeater section are completed and the pairs with opens, crosses, grounds, or low insulation have been cleared or tagged) include loop resistance, resistance unbalance, insulation resistance, cross-talk, transmission measurements at 1,000 cycles which are checked against calculated values, "singing-point" tests, and impedance-frequency runs on those circuits which have a poor singing point. In general, impedance runs are made on a sample of from 5 to 10 per cent of the circuits to check the correctness of loading and to locate irregularities.

Buildings—Equipment—Maintenance

Equipment associated with the cable is placed in eleven buildings along the route, five of which were newly constructed for the purpose and one of which, isolated in the Tehachapi Mountains, required the construction of residences for the operating personnel (Fig. 4). Equipment contained in these offices is required principally for phantoming, ringing, amplifying, and regulating purposes. Its extent may be appreciated from the fact that nearly 6,000 three-element vacuum tubes were supplied initially, although in many offices only sufficient equipment was installed to take care of a part of the circuits which ultimately will be in service in the cable.

In operating the cable, it is convenient to establish "circuit units" which consist of circuits lined up for a definite transmission value between the offices designated as "circuit-unit terminals"—San Francisco, Modesto, Fresno, Bakersfield, and Los Angeles. These circuit units are interconnected to form longer circuits, it being necessary merely to insert repeaters with the proper gain at the circuit-unit terminal offices. Each circuit unit is under the jurisdiction of a control station (San Francisco, Oakland, Fresno, Los Angeles) which is responsible for keeping it up to the required transmission standard. Test wires are set up in the cable between the various repeater points to enable each station to converse with all others as required in lining up and maintaining the circuits.

Variations in conductor resistance occasioned by daily and seasonal temperature changes may cause disturbances in the transmission losses of the various cable circuits. To compensate for this, a pilot-wire regulating system is installed in each circuit-unit section. This system consists essentially of a composited cable-telegraph circuit, or pair, known as a pilot wire, the resistance variations of which cause equipment in certain repeater stations to function and automatically compensate for variations in all circuit units. The circuits are of course lined up for average temperatures, and the regulators provide for temperature variations in either direction.

Future Extensions

It is expected that future demands for toll circuits on the Pacific Coast will result in further major extensions to the long distance cable network. Among the factors which tend in this direction are: the availability of tape armored cable which may be placed directly in the ground without a subway structure; the use of automotive equipment which makes feasible the extension of heavy cable plant into rougher country; and the use of gas pressure in cables to indicate potential trouble, which makes practicable the maintenance of cables through sparsely populated areas.

These items, and others which undoubtedly will be realized in the near future, permit forecasting the ex-

tension of the coast cable network to connect the Seattle area with the Southern California area and the ultimate use of cable to connect the Pacific Coast cable network with that of the rest of the Bell System.

Engineering Progress—1731 - 1831 - 1931

The second article in The Engineering Foundation's symposium "Has Man Benefited by Engineering Progress?" presented here predicts further industrial decentralization as a result of the wide availability of electric power.

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FOR SOME peculiar reason, in comparisons of present day life with that of preceding times, it seems to be assumed that progress invariably moves in one direction only. This of course is not necessarily true. We see this clearly if we review the history of the primary factor underlying the industrial changes of the twentieth century and the two centuries which preceded it.

That primary factor is power. Our life today, with its machinery, its mass production, and its teeming cities, is an outgrowth of changes in the nature of our power resources. The rural life which it supplanted likewise was determined by the nature of the power resources of the time.

Naturally the human race's work and welfare vary according to the amount of energy at its command. If energy is limited to human and animal muscle, depending upon vegetation for its fuel, it sets certain limits on the amount of possible production. Likewise, it dictates a dominantly agricultural mode of existence. However, if energy is derived from coal and water, the limits upon production tend to disappear and the importance of agriculture diminishes.

If we examine the nature of our energy resources in 1931 and compare them with the energy resources of 1831, and of 1731, we shall see quite clearly how the form of industrial structure always has been dictated by this energy factor. And by close examination, we shall see that the direction of these changes is not always the same.

The year 1731 was one in which population was widely diffused. Why? Because it was necessary to derive from agriculture the greater amount of the energy necessary to do the world's work; and agriculture is necessarily a scattered activity. Furthermore, without mechanical power there was little incentive to develop machinery or to organize people into factory groups.

In the following hundred years violent changes occurred. Freed from the definite limitations of human energy, and with the infinite resources of the coal pit at its command instead of the meager annual crops, industrial production was multiplied. To take advantage of this greater energy supply it was necessary to concentrate production because the power supply itself was concentrated. Great cities drew population from the countryside. The countryside could spare them because agriculture no longer had to produce the entire energy supply, and because agriculture itself simultaneously became more efficient.

That trend toward concentration, when superficially considered, seems to have continued to the present day. There are, to be sure, ample evidences of it. But there are still more striking evidences to the contrary; evidences that industry is tending once more away from concentration and toward diffusion.

These changes, too, are concerned with the nature of our energy supply. By 1831 power had changed the decentralized industry of 1731 into a centralized industry; in 1931 power appears to be changing industry back into a decentralized structure. The power supply of today is widely distributed. At virtually every point on the map, electricity is available in any quantity, whereas its predecessor, steam power, was to be had at relatively few points. The same is true of transportation, which after all is only another form of power.

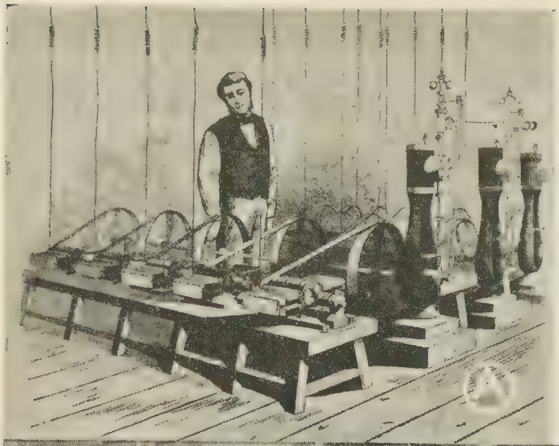
And industry is not slow to recognize the advantages of decentralization in terms of lower costs and improved working conditions. In this there is hope for those who view with despair our industrial evolution. Let them not conclude that, because we were headed toward industrial concentration for a century or more, we cannot reverse the direction of our development. We need not necessarily expect still more congested cities, still higher skyscrapers, nor a depopulated countryside. The industry of the future is more likely to reinhabit the countryside; to possess all the advantages of power machinery without the disadvantages of congestion which have hitherto accompanied it.

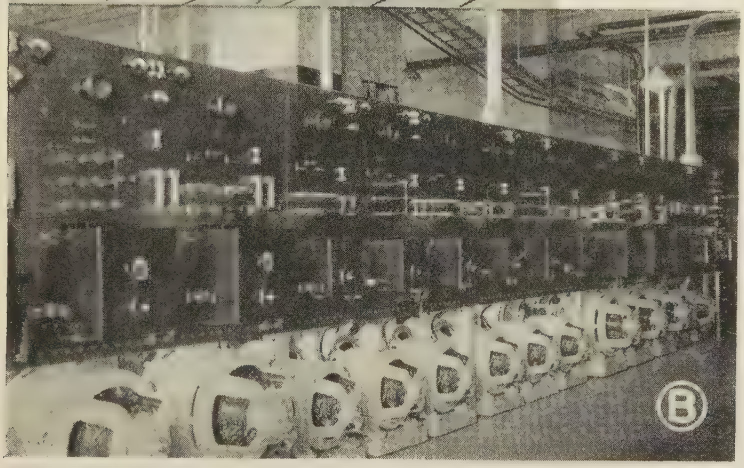
Second of a series of articles written expressly for The Engineering Foundation, and released to ELECTRICAL ENGINEERING for publication. *Not published in pamphlet form.*

Editor's Note: Pursuant to the invitation of The Engineering Foundation, the editors will be happy to receive comments, suggestions, criticisms, or discussions pertaining to this or the other articles published in this series.

Power Supply for

FASTER telegraphic communication is expected in this day of increasing speed of transportation; and speed must be accomplished with accuracy and the highest degree of service continuity. In order to meet these service demands electrically-operated devices in great variety, including belt-type message conveyer and pneumatic tubes in the larger offices, are finding their way into telegraphic service in ever-increasing quantities. Thus it is that the power plant is more than ever the heart of the system and every means must be provided to maintain an absolutely unfailing supply of electric energy.





(A) In September 1880 this and two other similar steam-engine-driven dynamo groups were installed by the Western Union at 195 Broadway, New York, the first in a telegraph office. The sketch is reproduced from the *Scientific American* of January 31, 1880. Each machine delivered 40 amperes at 70 volts; four of each group in series provided potentials of 70, 140, 210, and 280 volts, with the fifth serving as an exciter. One group furnished positive potentials; one negative potentials; and the third group was a standby unit. The plant replaced 15,000 gravity cells and released 90 per cent of a 10,000-sq. ft. floor for other uses.

(B) Some of the 37 motor-generators totaling 190 hp. recently installed on the eleventh floor of Western Union's new building at 60 Hudson Street, New York, to serve 1,123 automatic and 145 Morse telegraph circuits and about 500 ticker circuits. The present maximum power demand of the New York office totals 295 kw.; 75 kw. for telegraph circuits, 50 kw. for ticker circuits, 40 kw. for belt conveyers, and 130 kw. for pneumatic tubes. For the operation of message belt conveyers, 15,722 ft. of belt and 274 small motors totaling 76 hp. are used.

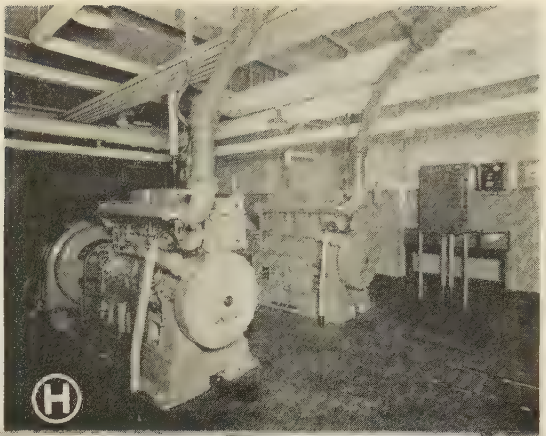
(C) Distribution switchboard on the eleventh floor power room of Western Union's New York office. Duplicate sets of feeders traversing separate shafts connect this board with the telegraph board (C). On the second panel may be seen a high-speed automatic throw-over switch developed specifically to shift telegraph equipment from regular to emergency circuits upon slight potential drop in the regular circuits, and to do so without loss of synchronism in automatic equipment and circuits. The switch accomplishes the transfer from one power source to the other in less than 0.1 sec. and represents one of the most important of recent developments in telegraphic equipment.

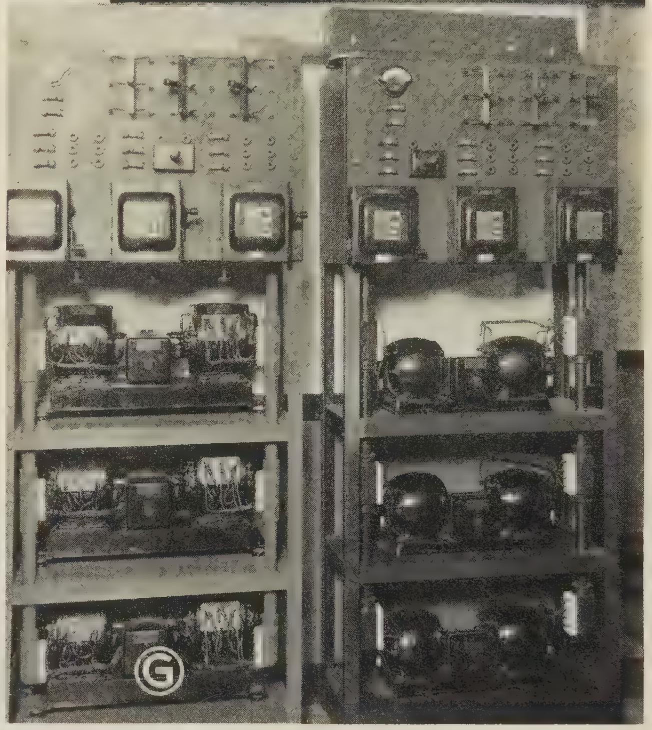
(D) Half of the main power switchboard in the New York office basement. This section controls telegraph power including belt conveyers, compressors, a portion of the lights, emergency generating units, and the emergency storage batteries.

From "Telegraph Power Plants," (**No. 31-62**) by E. W. Griffith, Western Union Telegraph Company, New York. Presented at the A. I. E. E. winter convention, New York, Jan. 26-30, 1931.

Telegraph Service

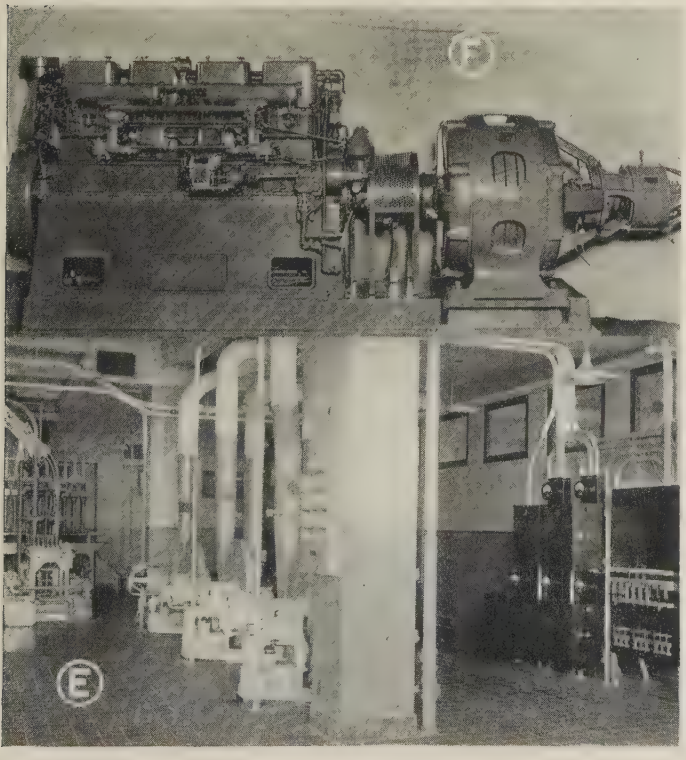
WESTERN Union policy now calls for the acquisition of power from local electric service companies instead of from private plants or batteries. This requires the use of motor-generator sets at the various offices for conversion to the desired voltages. Continuity of service is guarded by emergency engine-driven sets or storage batteries; or in the most important offices by both. At present there are about 1,085 Western Union stations equipped with a total of 4,320 motor-generator sets; 115 depend upon storage batteries for main power supply; some 450 isolated railroad stations still depend upon gravity batteries.





(E) High-speed pneumatic-tube blower installation at New York serving 50,000 ft. of tubing used for handling telegrams to 60 branch offices and 48 stations. A total of 363 hp. in blowers and compressors is required.

(F) An 8-cylinder, 200-hp., 1,200-r. p. m. gasoline-engine emergency set, typical of the new area in automotive design. The evolution of satisfactory high-speed, internal-combustion industrial-type engines and the economic advantages accruing from their use for emergency telegraph power supply have brought about some trial installations. In the new Western Union office in Boston an engine similar to that illustrated will drive a 125-kva., 208-volt, three-phase, 60-cycle alternator. It is expected to effect savings both in space required and in first cost.



(G) Motor-generators of 500-watt size and smaller generally are mounted on self-supporting steel frame "wall-type benches" specially designed to conserve space in the small offices where they are used. The sets shown are of special design, and each generator has a double commutator enabling it to serve an individual metallic circuit with 160 volts of both polarities. Switches, jacks, and cords provide for convenient transfers to meet emergencies.

(H) In some of the larger offices economies dictate two smaller emergency units instead of one larger one. The two shown are 6-cylinder, 80-hp., 900-r. p. m., gasoline engines driving 50-kva., 220-volt, three-phase, 60-cycle alternators in the Western Union's Pittsburgh office. Starting batteries and control panel may be seen in the background. All moving parts are covered and the exhaust manifolds are water-jacketed; a Maxim silencer usually is installed in the exhaust line. To decrease the transfer of noise and vibration to the building the entire sub-base is mounted on springs; and all connections, of course, made with flexible piping. In Western Union offices throughout the United States there are installed 114 emergency units; 67 gasoline, 23 gasoline (starting) and kerosene (running), 16 fuel gas, 7 semi-Diesel, and 1 full Diesel. The smallest unit is 8 hp.; the largest 120 hp.

Field Tests on Circuit Breakers

Tests show conclusively that the new high-speed oil-blast circuit breaker will clear the most severe faults within eight cycles or less, and from a system operating standpoint this type of breaker is reported as being definitely superior to other types. A careful analysis of the results shows further cause for the adoption of the multi-duty cycle. This and the two articles on the following pages outline the test procedure and discuss the conclusions reached.

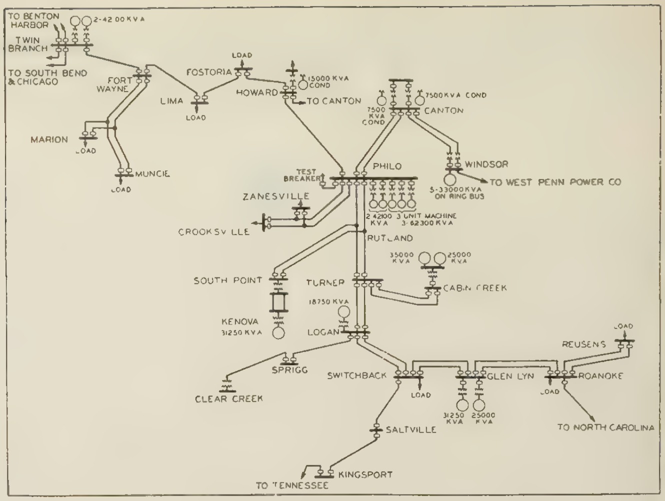


Fig. 1. System connections for the 1930 Philo 132-kv. circuit-breaker tests

CIRCUIT BREAKER field tests made during the summer of 1930 at the Philo (Ohio) plant of the American Gas & Electric Company, together with the contributions which these tests have made to the design and performance of circuit breakers are described in this article. Inasmuch as the tests involved the placing of short circuits directly on the 132-kv. bus of the largest generating plant on the entire interconnected system, before conducting such an investigation, careful consideration was given to the benefits which might be obtained.

Most prominent among the disclosures made by these tests are:

1. Circuit breaker performance.

An increased confidence in the higher ratings of circuit breakers was demonstrated. That the 8-cycle breaker has been realized was shown definitely, while in addition some progress was made toward the adoption of a multi-duty cycle. The explosion-chamber type of breaker was shown to be distinctly superior to the other types tested.

2. Circuit breaker development.

Weaknesses which now exist in the mechanical construction of the explosion-type breakers for high-speed operations but which can be corrected in future designs were pointed out.

3. System performance.

Added experience and confidence in plant operation have been provided through the large number of short circuits carried directly on the generating plant bus without apparent damage to equipment. Normally, the rate of rise of recovery voltage across the breaker contacts was found not to exceed 600 volts per microsec. System voltage dips were observed to be notably less severe when the high-speed explosion-chamber breaker was being tested than when testing the other types.

System connections for these short-circuit tests are shown schematically in Fig. 1. It may be noted that practically the entire interconnected system of the American Gas & Electric Company's group, together with some of the more important outside interconnections, were tied together in a practically normal set-up. With such an arrangement a short circuit of over 1,500,000 kva. was provided at the Philo bus, the major portion of which was supplied by the Philo plant itself.

In order that the tests might be carried out to take advantage fully of the entire 1,500,000 kva., a standard breaker of that rating with a 60-in. tank was used. This was mounted on a concrete mat foundation immediately adjacent to the 132-kva. Philo switchyard (see Fig. 2) and was connected to the bus by short overhead 250,000-cir. mil copper conductors.

Test Procedure

The first group of tests consisted of 28 shots on the breaker equipped with standard butt-type explosion-chamber contacts. Of these, 7 were made with the Philo generators alone supplying the short-circuit current and with no transmission lines connected to the short-circuited bus; 4 of these 7 were made with full plant capacity; 5 shots were made with the maximum available system capacity and undoubtedly resulted in a duty on the circuit breaker either at or more than its full rating.

The second series of tests consisted of 40 shots on the same breaker equipped with the new oil-blast explosion chamber and contacts (see Fig. 3). These new explosion chambers have been described in previous publications (see *The Oil-Blast Circuit Breaker*, by D. C. Prince and W. F. Skeats, ELECTRICAL ENGINEERING, Feb. 1931, Vol. 50, p. 134). These tests included a total of 16 shots with the maximum rate of recovery voltage and with no lines connected to the bus. In 7 of these 16 shots full capacity of the Philo plant was connected to the bus thus providing short circuits of from about 1,000,000 to 1,285,000 kva. Six shots were made with the maximum available system capacity, all of which as in the previous case imposed full rated duty or more upon the breaker.

The third and final group of tests consisted of 13 shots only, the tests having been cut short on account of a broken bushing on the breaker used as a closing breaker for opening shots on the test breaker. In these final tests the same breaker was used but was equipped with the older type of segmental contacts and explosion chambers. Six shots were made at intervals of from ¾ to 1½ min. with light duty and rates of recovery-voltage rise; the succeeding 6 shots were made at intervals of from 1 to 3 min. with the maximum available system capacity. The final shot, which originally was intended to be the first of a series, was made with full capacity of Philo plant and with the medium rate of rise of recovery voltage obtained with one short line connected to the short-circuited bus.

In all tests the rate of recovery-voltage rise was varied to suit by connecting or disconnecting lines to Philo generating station bus. By such manipulation three rates of recovery-voltage rise were obtained: namely, 270, 600 and 2,400 volts per microsec.

Test Results and System Performance

By

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SYSTEM DISTURBANCES due to the tests were not serious and caused but little trouble and but few complaints except from consumers at points nearby. Recording voltmeters were installed during the tests at all of the important 132-kv. substations on the system. Typical charts from these recorders are shown in Fig. 4. While inertia and overtravel in a voltmeter of this type are responsible for some of the variations in the charts, nevertheless a clear comparison may be noted between the severity of disturbances caused by high speed and by ordinary circuit breakers. The most striking comparison is revealed by the charts obtained at points close to the Philo plant, such as those taken at Crooksville. Here again the inertia of the moving pen instrument plays a large part in the record obtained, but at the same time a fairly accurate comparison may be drawn. In addition it is felt that a dip, the duration of which is too short for the recording voltmeter pen to follow, may also be too short to cause a synchronous machine to fall out of step.

From "Oil Circuit Breaker Tests—Philo 1930, Aims, Set-Up and Results from a System and Operating Viewpoint," (**No. 31-25**) presented at the A. I. E. E. winter convention, New York, Jan. 26-30, 1931.

Summary of Important Results

In general the principal objects for which the tests were undertaken were quite fully realized. The manner in which the tests will prove of real benefit from the standpoint of system performance is indicated in the following listing:

1. 2,500,000-kva. breakers now feasible.

In view of the fact that a test breaker equipped with a 60-in. tank successfully interrupted a 1,735,000-kva. short circuit, there is little doubt

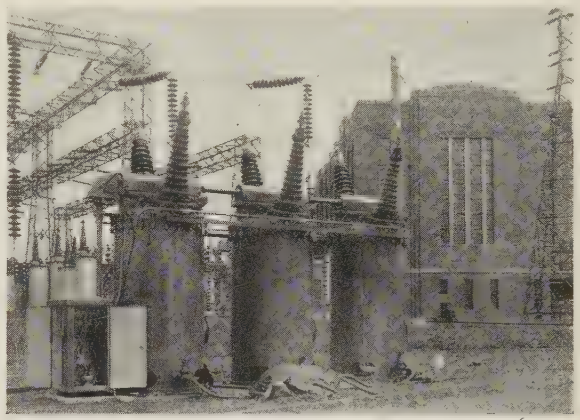

Fig. 2. The 132-kv. 1,500,000-kva. oil circuit breaker with 60-in. tank used in the tests. Note proximity to substation and power house structures

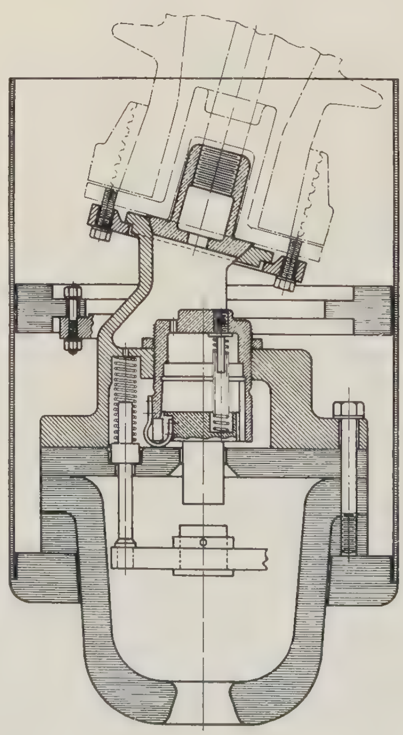

Fig. 3. Circuit breaker explosion chamber with new oil-blast contacts

but that standard breakers with 72-in. tanks will operate satisfactorily under their rated duty of 2,500,000 kva. This positive assurance is of value, in that it enables the engineer to plan system expansion along the most desirable lines without being hampered by fears of circuit-breaker limitations.

2. The 8-cycle breaker a definite realization.

All short circuits in tests on the new oil-blast explosion chambers and contacts were cleared in 8 cycles or less. High-speed breaker operation will greatly accelerate the clearing of a faulty line, which is particularly important where two or more parallel lines are being protected. It is also valuable for preventing a complete loss of voltage on one of two interconnected systems by quickly clearing the interconnecting tie when the load approaches its static-stability limit.

3. Increased confidence in plant performance.

Ability of the generating station equipment to withstand these heavy short circuits without apparent damage has proved beneficial in the training and experience of the operating personnel at Philo; a greater degree of confidence in plant performance has resulted.

4. Adoption of the multi-duty cycle predicted.

Definite progress for the adoption of the multi-duty cycle for circuit-breaker performance has been realized through a demonstration of the ability of the breaker to handle successively a large number of heavy short circuits without intermediate inspections or changes of oil.

5. Design defects were revealed.

Two explosion-chamber failures occurred during the course of the tests. These were caused apparently by the general weakness of the chambers and not by other faults of design. It is believed that subsequent changes in design will prevent a recurrence of such failures.

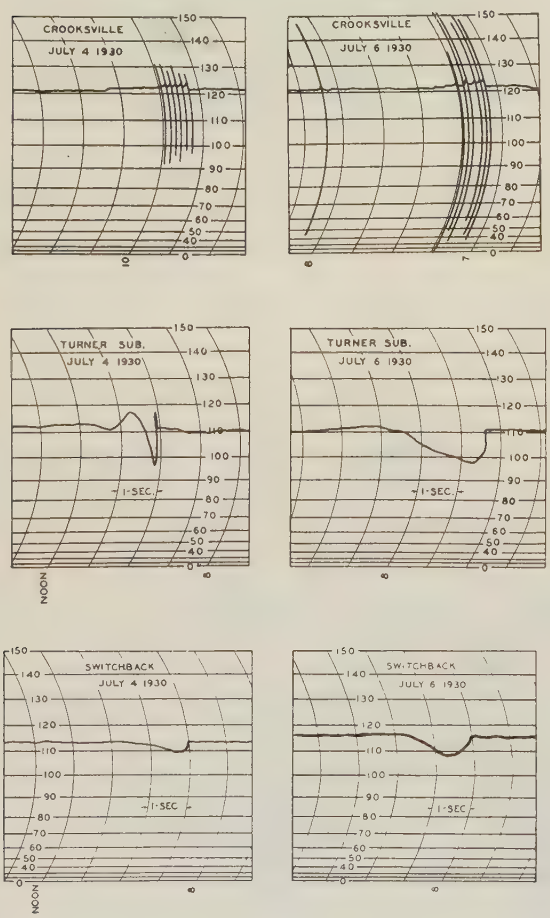

Fig. 4. System voltage dips at three 132-kv. substations while testing with (left) high-speed oil-blast contacts and (right) butt-type contacts

Test Results and Circuit Breaker Behavior

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PERFORMANCE of different types of breaker contacts, and rates of recovery-voltage rise, are the principal items receiving particular attention in this analysis of the Philo circuit breaker tests. As stated previously the rate of recovery-voltage rise was manipulated by varying the number of lines connected to the Philo station bus.

In the 28 tests made with the butt-type contacts, the kva. interrupted ranged from 268,000 to 1,640,000. The range of short-circuit duration was from 7.5 to 39 cycles, while breaker operating time varied from 7 to

From "Circuit Breaker Field Tests on Standard and Oil-Blast Explosion-Chamber Oil Circuit Breakers." (**No. 31-26**) presented at the A. I. E. E. winter convention, New York, Jan. 26-30, 1931.

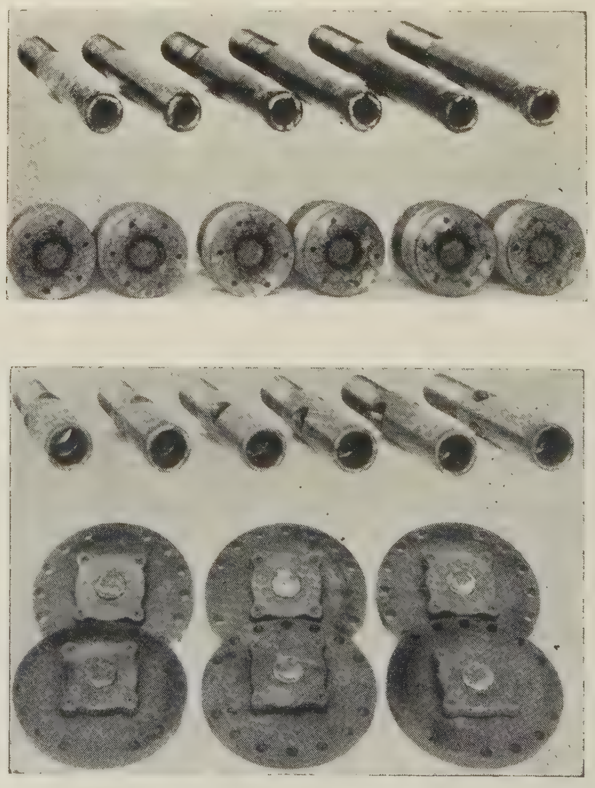

Fig. 5. Condition of contacts after tests. (Above) butt contacts after 28 tests; (below) oil-blast contacts after 40 tests

38 cycles. Arc duration ranged from 4.5 to 36 cycles; arc length from 11.5 to 32 in. Maximum tank pressure recorded in this series of tests was 36 lb. per sq. in., while the average was 10 lb. Although slight mechanical difficulties were encountered they were not of a fundamental nature and will be corrected quite readily by minor changes in design. Although these butt-type contacts were somewhat burned after the tests, as may be seen in Fig. 5, their condition was such that they could have been kept in operation for many more tests.

Superiority of New Explosion-Chamber Contacts

Results of the 40 tests made with the hollow-type contacts operating in the new type oil-blast explosion chamber the kva. interrupted ranged from 177,000 to 1,735,000. The short-circuit duration varied from 5.5 to 9 cycles, and breaker operating time from 4.5 to 8 cycles. Arc duration varied from 1.6 to 5.7 cycles, while arcs from 2.5 to 14.5 in. were recorded. On the last six tests of this group, all in excess of 1,500,000 kva. and made at intervals of about two minutes, the average tank pressure was 8 lb. per sq. in., the maximum being 11 lb. The condition of these contacts after test may be seen also in Fig. 5. Actual measurement indicated that a total of less than ¼ in. of contact metal had been burned away from the arcing surfaces. In order to determine their suitability for further operations, these contacts were returned to the factory and subjected to a heat run using twice the breaker-current rating; the resulting temperature rise was less than 30 deg. cent.

In the third series of tests with the segmental-type contacts, 7 tests ranging in value from 940,000 to 1,400,000 kva., were made in 10 min. Short-circuit duration varied from 12 to 18 cycles, corresponding breaker operation ranging from 11 to about 15 cycles. Arc duration varied from 4.5 to 7.2 cycles; arc length from 11.3 to 14.8 in.

A comparison between the performance of the butt-contact breaker and that of the oil-blast contact breaker is shown in Table I. Effects of the rate of recovery voltage rise upon arcing time and arc lengths may be noted quite readily. Average arc duration for the butt-type contacts was 8.6 cycles as compared with 3.5 cycles for the oil-blast contacts. A comparison between arc lengths shows an average of 18 in. for the butt contact and 6.8 in. for the oil-blast contact. Average contact-opening speed for the oil-blast breaker was 9.5 ft. per sec. as compared to 13 ft. per sec. for the butt contact.

TABLE I—PERFORMANCE COMPARISON FOR BUTT AND OIL-BLAST BREAKER CONTACTS

Lines connected to bus	Calculated volts per microsecond	No. of tests	Av. arc duration cycles	Av. arc length in.
Butt Contacts				
3	270	17	6.2	15.5
1	600	4	7.1	17.0
0	2400	7	15.0	24.5
Total 28 tests		Average	8.6	18.0
Oil-Blast Contacts				
Lines connected to bus	Calculated volts per microsec.	No. of tests	Av. arc duration cycles	Av. arc length in.
3	270	15	2.6	4.5
1	600	9	3.7	7.1
0	2400	16	4.1	8.8
Total 40 tests		Average	3.5	6.8

Conclusions

After a careful analysis of the test results, the following conclusions seem justified:

1. Rate of recovery voltage rise affects to some extent the interrupting performance of the breaker.

2. Standard breakers now available commercially will operate satisfactorily on the highest rates of recovery-voltage rise now encountered (about 600 volts per microsec.).

3. The oil-blast breaker has demonstrated a distinct superiority over the other types of breakers tested.

4. Standard oil-blast breakers now available commercially possess an over-all operating time of 8 cycles or less.

The Orient Turns to Automatic Telephones

By
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Member A. I. E. E.

MANY great poets of China repeatedly have described the beauty of Hangchow. It is the capital of the Province of Chekiang, one of the smallest but richest in the country. At one time its leading glory was the fame of its beautiful landscape, but the town now is winning a standing also through the increasing application of modern engineering. Among several developments the most recent and perhaps most important is the new automatic telephone exchange system which now serves the whole area.

Only a little more than twenty years ago telephone development was started by commercial enterprise in this ancient capital; subsequently the system was transferred to a government organization. A little later again to become a commercial enterprise; present

Contributed by Y. K. Chow, chief engineer, Provincial Telephone Administration, Chekiang Provincial Government, Hangchow, China. Not published in pamphlet form.

developments are being made by the Provincial Government. In the early days telephone service was not in the general demand that it is today; hence growth and development came slowly. Also, financial difficulties and the lack of suitable technical study caused the design and growth of the system to be governed largely by expediency. Subsequently the age of the switchboard and other equipment, and the poor condition of the line plant, prohibited any major attempt for modernization without complete system reconstruction.

In 1927 the Provincial Government decided to construct a network of long distance telephone lines to link together all the cities in the province, and to connect also to Nanking and Shanghai. Since that time toll service has grown rapidly, with a consequent expansion in the problem of improving local service in the Hangchow area. Meanwhile, the city's telephones had increased gradually until there were five magneto-type exchanges scattered over the whole area, the largest of which had a capacity of 1,200 lines. Early in 1929 the government completed its plans for taking over the existing exchanges from the operating company and invited bids for system rehabilitation from leading telephone manufacturers throughout the world.

In addition to the economic questions that had to be settled in connection with such a major undertaking, there were the problems of language difficulty, training and maintenance of staff and operators, and the ever-present matter of public opinion. Ultimately the rotary-type of machine-switching system was adopted as best suiting the service requirements, as well as satisfying economic limitations.

The present equipment consists of one 2,700-line exchange with a building and power plant which provides for an ultimate of 5,000 lines, and one 300-line exchange designed and equipped for an ultimate of 500 lines. The existing manual exchange in the south of Hangchow will be converted shortly to automatic operation. Also it is hoped that conversion of the rural exchanges to automatic operation may be carried out in the near future.

Radiotelephone Service is Expanding

With 91 per cent of the world's telephones already provided with facilities for direct international conversations, plans and developments are progressing to provide extensions. Present services are outlined here and some data given covering the Hawaiian link now under construction.

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SINCE January 7, 1927, when commercial radiotelephone service first was established between New York and London, continuous and important developments have been made in the application of radiotelephony to intercontinental communications. Also, there has been a generally sustained increase in the public demand for this class of service to the end that today the Bell System in cooperation with the British Post Office has four radiotelephone circuits to London, the original long-wave channel supplemented by three short-wave channels. By means of these, telephone subscribers in the United States, Canada, Cuba, and Mexico may be connected to practically any telephone in Europe, in the city of Ceuta, Northern Africa, in part of Australia, and in Java, Dutch East Indies.

Service to all European points and to Ceuta is furnished through London where connection is made to the submarine cables and land line facilities making up the European telephone network. As yet Russia, Greece, Turkey, and a few of the Balkan States cannot be reached from the United States over this network. Service to Australia is given by switching the New York-London radio circuits at the latter point to a short-wave radiotelephone channel between London and Sydney. Service to Java is furnished through London to Amsterdam or Berlin, where connection is made to a short-wave radio channel operated between those points and Java by the Dutch Telephone Administration.

Transatlantic telephone messages between the United States and Europe during the first six months of 1931 were about 20 per cent greater than for the corresponding period for 1930. While the basic rate, which is the rate from New York to London for a 3-min. period, was reduced from \$45 to \$30 on May 11, 1930, the increase in traffic is considered very satisfactory in view of the general business conditions which have

From "Intercontinental Radiotelephone Service From the United States" (**No. 31-129**) presented at the A. I. E. E. Pacific Coast convention, Lake Tahoe, California, August 25-28, 1931.

existed on both sides of the Atlantic, and is an indication that this service continues to be of increasing usefulness to the public.

In December 1929, a ship-to-shore short-wave radiotelephone service was established on a commercial basis through New York with the steamship "Leviathan." Since that date service has been opened with five more of the larger liners plying between North America and various European ports, the "Olympic," "Homeric," "Majestic" the "Belgenland," and the "Empress of Britain." While at present this service is furnished normally only to ships in the Atlantic area, contacts were made last winter with the "Belgenland," during a large part of its cruise around-the-world, and with the "Homeric" then cruising in the Mediterranean.

The Bell System, in cooperation with the International Telephone and Telegraph System, established on April 4, 1930, a short-wave radiotelephone channel between New York and Buenos Aires. Through Buenos Aires, service may be given by land line connections not only to other parts of the Argentine Republic, but also to the great majority of telephones in Uruguay and Chile.

Construction has been completed recently to the end that the South American service could be enlarged to include Rio de Janeiro, Brazil. Plans for the radiotelephone system to work with Rio de Janeiro were on a basis somewhat different from those for the services heretofore established from the United States, and it may be of interest to outline briefly the arrangements made. The previously established services contemplated the full-time use of one or more complete radiotelephone circuits whereas service to Rio de Janeiro was planned on the basis of sharing facilities already provided for service to Buenos Aires.

In the United States the transmitter operating with Buenos Aires was provided with an additional antenna directed toward Rio de Janeiro; and at the receiving station there was installed a complete new receiving unit adjusted to receive from Rio de Janeiro. At the transmitting station, switches were provided for the rapid transfer of the transmitter from one antenna to the other, while at the receiving station the two receiving units serve to enable the New York control office to keep in constant touch with both distant transmitters. This arrangement permits the maximum use of equipment and facilities and seems to offer a promising means of providing for the extension of radiotelephone service to a number of points to which it may be desirable to furnish service, but where the cost of apparatus for full-time channels cannot at the time be justified. This arrangement offers also an opportunity to reduce the number of frequency assignments required, because a number of points may be served from one transmitter using the same transmitting frequencies where the conditions permit. It is expected that this general method will find considerable application in economically extending existing services. One set of transmitting equipment, which is the expensive item, can be used for service to a number of points to the extent permitted by traffic loads, by merely providing the necessary antennas and receivers.

The radiotelephone services established to date and previously referred to, now make possible the connection of telephone users in this country to more than 91 per cent of the world's telephones. From the map shown in Fig. 1 it may be seen that these existing facilities provide the ground work for furnishing telephone service from North America to the East and South. Preliminary studies have been made of the possibilities, probable demand, and usage of telephone service from the United States to all parts of the world. A world-wide service of this kind is something that is extremely interesting to contemplate, but it is obvious that while considerable progress has been made in establishing such a service, an objective of this magnitude must be approached with due consideration to such factors as equipment and antenna development, costs, probable usage, differences in time and languages, and availability of satisfactory wavelengths.

In line with the desired objective of extending service where practicable, plans have been completed recently and construction work is now in progress to establish in conjunction with the Imperial and International Communications, Ltd., a short-wave radiotelephone channel between New York and Hamilton, Bermuda,

Fig. 1. International radiotelephone connections of the Bell System as of August 1931

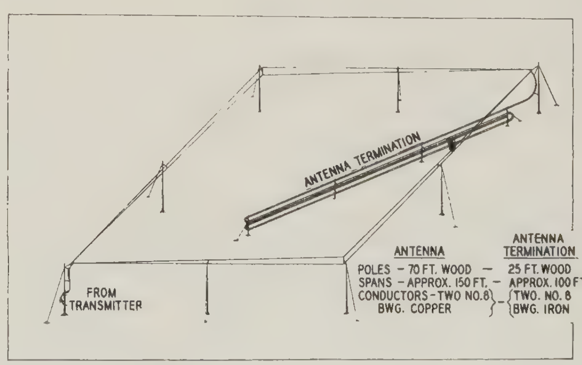

Fig. 2. Schematic diagram of the "horizontal double-V" transmitting antenna for Hawaiian service

there to connect with the land line facilities serving the Bermuda Islands. This radio circuit in general will closely resemble the other short-wave radio circuits previously established. The transmitter will be considerably smaller and of lower power, however, (500 watts unmodulated carrier outputs compared to 15 kw.) since the distance to be covered is only about 700 mi. compared to about 3,400 mi. between New York and London, 4,800 mi. between New York and Rio de Janeiro, and 5,300 mi. between New York and Buenos Aires. It is expected that the Bermuda system will be ready for operation late this year.

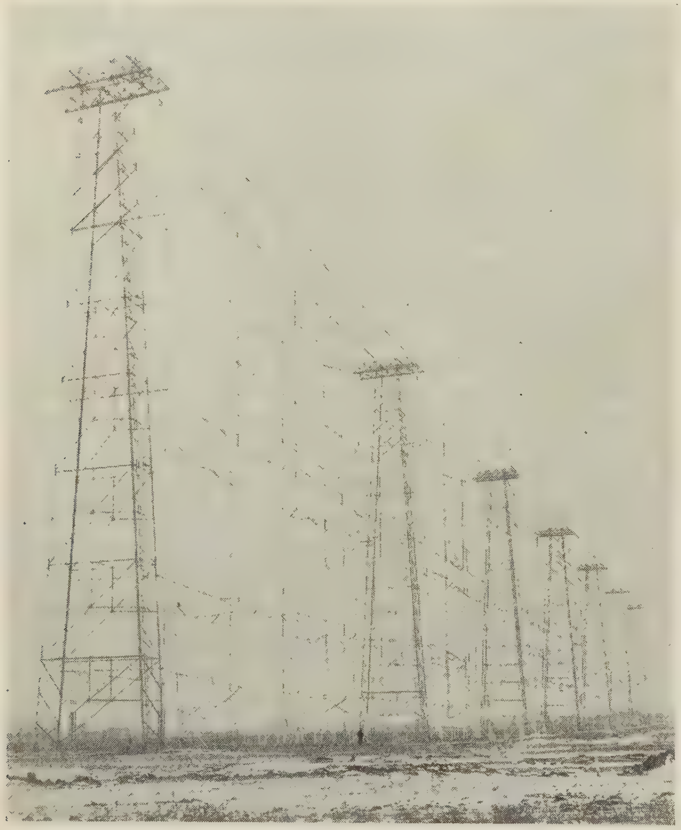

Fig. 3. Antenna towers and curtains of the type used for South American and transatlantic service

During the past $1\frac{1}{2}$ years right-of-way has been acquired and two test antennas have been constructed at Bradley, Maine, near Bangor. These test antennas were constructed for experimental purposes looking forward to supplementing the existing New York-London long-wave circuit now working at 60 kc. with an additional long-wave circuit operating at 68 kc. These antennas have proved effective at Bradley, and plans now are in progress for the construction of a new long-wave transmitting station at that point. The receiving station for the additional long-wave circuit is planned for Houlton, Maine, the receiving point for the existing long-wave circuit. Owing to the magnitude of this undertaking it is expected that about three years will be required to construct the new long-wave system.

In the Pacific area the points which in the future might logically be furnished with direct radiotelephone connection with the United States include the Hawaiian and Philippine Islands, Japan, China, Australia, New Zealand, and Alaska. A transpacific short-wave radiotelephone system is now under construction, joint arrangements having been made with the Mutual Telephone Company of Hawaii to set up the initial circuit from California to Hawaii.

The transmitting station for the transpacific service is being established at Dixon, Calif., in the Sacramento Valley about 20 mi. southwest of Sacramento and the receiving station, at Point Reyes, Calif., on the Pacific Coast about 35 mi. north of San Francisco. The Dixon site contains about 640 acres and the Point Reyes site about 520 acres. These sites were selected after a rather extensive survey of the west coast of the United States during which consideration was given to avoiding, for receiving station purposes, areas too near radio transmitting stations and other sources of interference and, for transmitting station purposes, areas too near radio receiving stations. Consideration was given also to obtaining for both stations tracts of land of reasonably flat contours, free of mountain ranges which subtend angles of more than 2 or 3 deg. with the horizontal in the directions of transmission or reception. It was necessary that both sites be economically accessible for telephone, power, and transportation facilities.

The transmitter building at Dixon, a 40 x 60-ft two-story brick-and-concrete structure, is designed to accommodate two equipments although only one will be installed initially. In general, the transmitter is similar to those at Lawrenceville, N. J., consisting of several individually and carefully shielded units mounted side by side. These units include a two-stage audio-frequency amplifier, a modulator, a piezoelectric quartz crystal oscillator with two harmonic generators, and a two-stage radio-frequency power amplifier. The output of the two-stage audio-frequency amplifier is used to modulate the plate voltage of the modulator unit which contains two 250-watt tubes in a push-pull circuit. The modulator receives its carrier frequency direct from the second harmonic generator which in turn is fed by the first harmonic generator and the crystal oscillator.

The crystal oscillator is contained in an electrically heated oven the temperature of which is carefully regulated to 50 deg. cent. $\pm$ 0.05 deg. This arrangement holds the transmitted carrier frequency constant within very narrow limits. The output of the modulator unit then is applied to the grids of the two-stage radio-frequency amplifier. The first stage contains two 10-kw. water-cooled tubes and the second stage contains six. These tubes are arranged in push-pull circuits and the entire system is carefully balanced to ground. The unmodulated carrier output power of the last-stage amplifier is about 15 kw. which,

under conditions for 100 per cent modulation, is equivalent to 60 kw. at the peak of the modulation cycle.

From the transmitter the radio-frequency energy is fed over an open-wire transmission line to the transmitting antenna about 800 ft. south of the building. This initial transmitting antenna for the Hawaiian service is of the horizontal double-V type (Fig. 3) recently developed by the Bell Telephone Laboratories. This type of antenna is a diamond-shaped structure consisting of one or more horizontal elements supported on wooden poles, the longer axis pointing toward the desired receiving station. The antenna is driven from the rear apex of the diamond and when suitably terminated at the opposite end, has a good unidirectional characteristic. This antenna has another very desirable characteristic in that, within certain limits, it is effective over a range of frequencies. For transmitting to Hawaii the initial antenna is designed to handle two frequencies in the vicinity of 7 and 14 megacycles. While varying somewhat with the frequency being transmitted, the gain of this antenna as compared to a single-element half-wave vertical antenna ranges from 8 to 16 db.

Comparison of the details revealed in Figs. 2 and 3 will indicate the relative simplicity, and consequently the relative economy, of the horizontal double-V antenna. This is even more strongly indicated when it is considered that in the vertical type shown each antenna occupies two spans between the 185-ft. steel towers, and that each antenna is effective for only the one frequency for which it was designed. The development of this relatively inexpensive antenna is of particular significance at this time because, if radiotelephone service is to be opened to points which do not justify the provision of individual channels, the number of antennas for use with existing equipment may be expected to increase materially in the next few years.

At the Point Reyes receiving station the building is a one-story 26 x 40-ft. semi-fireproof structure of reinforced concrete designed to house several radio receivers and their associated power and voice-frequency apparatus. However, the initial installation comprises a single receiver made up of individually shielded units. It employs two stages of screened-grid radio-frequency amplification, a first detector, an intermediate-frequency amplifier with input and output filters, a second detector and an audio-frequency amplifier. From the output of the intermediate-frequency amplifier a part of the received energy is diverted, put through a special two-stage intermediate-frequency amplifier, rectified, and supplied to the automatic gain control which in turn tends to keep the receiver output volume constant by controlling the bias potential on the radio-frequency amplifier and the first-detector grid circuits. In this receiver the first two panels which contain the equipment up to and including the first stage of intermediate frequency amplification are duplicates. By means of a switch the equipment in either of the first two panels may be connected to the rest of the receiver. This arrangement makes it possible to switch from one frequency to another with only slight tuning adjustments and therefore with the minimum loss of time.

The receiving antenna is similar in construction to the transmitting antenna already described. It is about 500 ft. northeast of the receiving building and is designed to receive two frequencies, 16,195 kc. and 7,535 kc. Connection to the receiver is by means of a concentric-conductor transmission line run underground at a depth of about 18 in. This type of line is used because of its low transmission loss at high frequencies and because of the shielding effect of the grounded outer conductor. The outer copper tubing is of 1⅝-in. outside diameter while the inner copper tubing is of ⅜-in. outside diameter. Spacers are of Isolantite.

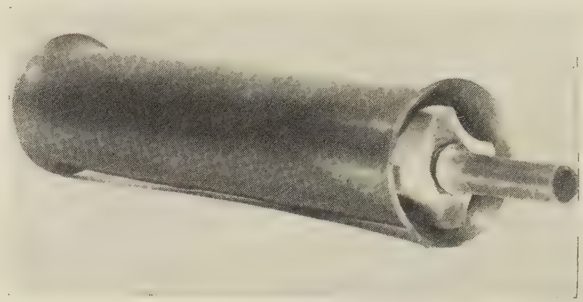

Fig. 4. Section of concentric copper transmission conductor for connecting the receiving antenna to the radio receiver

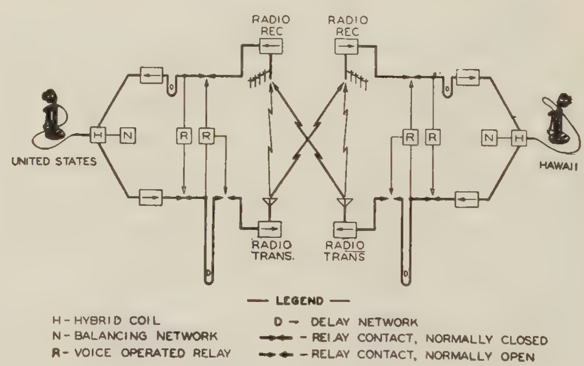

Fig. 5. Fundamental arrangements of voice-operated devices for the transpacific radiotelephone circuit

At San Francisco the terminal control equipment will be located on the first floor of the Pacific Telephone and Telegraph Company's Grant Avenue toll building. To this location are brought the transmitting and receiving radio circuits, as well as the interstation communication and order wires. Equipment at the terminal station is the same as that installed at New York for the transatlantic services and which has been described in a paper previously presented.

From the terminal control room the radio circuit is carried to a special position at the San Francisco toll switchboard where connection may be made to land line circuits extending to all parts of the country.

It is expected that service to Hawaii will be available commercially early in 1932. To the people of Hawaii the establishment of this service will offer for the first time a regular telephone connection with the North American Continent. In addition, it will afford opportunities to make tests and obtain actual field data leading to still further extension of radiotelephone communication to such other transpacific points as may be decided upon in the future.

Voice Training on a Scientific Basis

TRANSMITTING, recording, reproducing, and amplifying of sound by mechanical, electrical, and photographic devices have brought an industrial need for an exact science of sound. In 10 years of research with modern instruments and laboratory methods, and with the latest knowledge of physiology, enough has been learned to establish principles for training a voice understandingly although much additional research is needed.

Hundreds of tests were made upon voices, trained and untrained; for example, an investigation of the expulsion of breath during phonation. The singer put on a French gas mask; in its eye-piece was a telephone transmitter; rubber tubing went from the mask to a spirometer and to the air. Flutter valves allowed breathing in from the outer air and out into the spirometer, but stopped escape into the outer air or out of the spirometer. The specially designed transmitter was connected to a special amplifier and thence to an oscillograph. The singer sang several tones on different vowels at various pitches and intensities, each tone held 8 to 12 sec. Readings of the volume of air expelled per second were taken.

Observation of great singers has shown that they never produce a "dead," steady tone except at pianissimo. The tone fluctuates in intensity with perfect regularity. This fluctuation, very wide at high intensity, is accompanied with a slight fluctuation of pitch. This vibrato is the result of an impulse periodically applied to all the muscles which coordinate in the act of phonation. Its frequency is about six per second, but can be increased. Thus all the time the singer is phonating he actually is alternately singing and silent, rapidly and regularly. As the intensity rises the "on" impulse is more vigorous and the swing of the vibrato increases. Since at mezzo forte, when the technic is good, the intensity of the tone should increase as the pitch rises nearly up to the top of the singer's range, the vibrato should increase in amplitude as the scale is ascended. The vibrato decreases as the intensity drops until a point is reached at which a stream of air actuates the vocal cords, when it disappears altogether. This concept of an "on" and "off" impulse is very different from the old notion of steady control of a stream of breath.

A great voice is not due to anatomical peculiarities but to mental and emotional capacity and tractability. The human voice is a sound-producing instrument governed by the laws of sound and of physiology; it consists of a motive force (the *pressure* of the breath), a vibrator (the vocal cords), and a resonator (a set of adjustable cavities in the head and throat). Voice starts in a mental concept which brings the necessary muscles into action. A singer must have a mental concept of the pitch which he is about to sound. If this concept, or the receiving mechanism of the ear, be faulty, a pupil cannot be made to sing, although his speaking voice may be trained. Two groups of muscles, one of seven and the other (far stronger) of two, bring the vocal cords into tension and hold them there. When a mental concept initiates the nerve impulses supplied to the larynx, these muscles come into action and the vocal cords are set to the proper length, tension, and position. If the singer starts from pianissimo, where the breath pressure is at a minimum, and increases the intensity and therefore the breath pressure or the amplitude of the vibrato to fortissimo, the muscles must take on additional tension. The lighter muscle group should take tension to a point at which it would overload; then tension of the stronger group must be increased.

So long as the vocal cords are held in tension against pressure of the breath by means of additional tension on the lighter muscles, the singer or speaker is using the "upper register" (falsetto); as soon as the stronger muscles start to take on added tension, he is using the "lower register." *Registration* provides the proper method of controlling the *intensity*, not the pitch. The registers should be isolated and trained separately; only when fully developed should they be coordinated. Improper coordination of the laryngeal muscles accounts for the partial or total loss of voice of most of the great singers at an age at which they should be in their prime.

From "breath expulsion-intensity" curves, a person trained in this new science will be able to make an accurate technical criticism of a voice without having heard it. The "breath control" doctrines, long ac-

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cepted, are fallacies. Tremolo is caused by a fluttering of the walls of the resonating cavities. The vibrato is the means for moving the voice correctly from tone to tone; it allows the singer to keep perfect time and rhythm; it can be improved and controlled by training.

The range of every properly produced voice should be at least three octaves; some persons may attain nearly four. Faulty registration and resonance adjustment can curtail the range 50 per cent or more; also reduce the power to an incredible degree. The mouth should not be used as a resonator. When a person is phonating the muscles used in the act of phonation should not be relaxed but in proper tension balance.

There is no fundamental difference between the singing and speaking voices except in so far as vowels are more sustained in singing. There is no vibrato in speech. In singing the intensity is far greater (thus the general pitch is far higher), the range far wider, and articulation much stronger than in speech. In speech, low tones are most effective; hence all normal speech should be in the pure lower register.

Abstracts

Of Papers Presented at the Pacific Coast Convention

INTERPRETIVE abstracts of all papers presented at the Pacific Coast A. I. E. E. convention (August 25-28, 1931) are presented herewith, only excepting those papers already published in this or preceding issues of ELECTRICAL ENGINEERING. Members vitally interested and wishing to obtain immediately pamphlet copies of any of these papers are requested to use the order form appearing on p. 770 of this issue. In response to popular demand and within its space limitations ELECTRICAL ENGINEERING subsequently may publish certain of these papers, or technical articles based upon them.

Electric Power In the Wood-Products Industry

By C. E. Carey[1] and K. L. Howe[1]

For references to business affiliations see listing on page 756.

THIS paper deals with electric power in those industries in the Pacific Northwest which use forest wood as raw material for manufacture. It covers briefly the electric power requirements of these industries, and presents some statistics as to electric power consumption. During the past two decades the electric energy consumed in the lumber, pulp, and paper industries of this district has grown to a value comparable to the total amount generated by all of the central stations operating within the same geographic area.

General information concerning the types of motors used for various operations is given, along with some statistical information as to average power requirements for certain machines and illustrations of typical installations. The paper deals with the general application of electric power within the wood-products industry, and does not cover the technical requirements of each of the motor applications.

The methods of manufacturing within the various plants, and the requirements of the various processes determine the extent to which electric energy is used in these various mills. The success of electric power utilization is indicated, however, by an annual energy consumption of more than 2,000,000,000 kw-hr. (**A. I. E. E. Paper No. 31 M 1**)

Electrical Equipment for Oil-Field Operations

By H. C. Hill[2] and J. B. Se Legue[2]

IN THE application of electricity to the work of drilling for oil and pumping the wells, many problems peculiar to the oil industry have been encountered. This paper presents some of the more interesting features of these applications, and is confined to a discussion of the duty involved and of the design of the apparatus for the purpose. Although the petroleum industry still relies largely upon engine power, strides have been made during the past ten years in the development and application of electrical apparatus, and in the extension of central station power into oil fields. Oil companies are giving an increasing amount of attention to its use.

A comparison is made between the methods and equipment involved in cable-tool drilling and rotary drilling. Briefer consideration is given to well-pumping control equipment, electrical protection measures, and the air-gas lift. The many other uses for electric power in oil production and handling are considered as beyond the scope of this paper.

Electric power for oil-field operations was first used in the eastern fields more than 30 years ago, but the extensive use of this form of power did not begin until 10 or 12 years later, when it was introduced in the California fields. Most of the new

developments which since have been made in the design and use of electrical apparatus for oil-well drilling and pumping have been tried out and perfected first in the California fields before being adopted elsewhere. This has been due not only to the field conditions encountered there, but also to the availability of dependable central station power service in all of the fields.

Of the tremendous connected horsepower in the oil industry in the United States, it is understood that only 7 per cent is electrical. In California alone there is 1,500,000 hp. installed, of which only 15 per cent is electrical. This indicates the potential possibilities for electrification. (**A. I. E. E. Paper No. 31-128**)

Correlation of Induction-Motor Design Factors

By Vaino Hoover[3]

AN ANALYSIS of stator resistance, wire size, horsepower rating, and air-gap density as a function of the flux per pole per unit-length of lamination stacking, stator slot shape and slot insulation, rotor diameter, and flux densities in the stator teeth and core, is given in this paper.

The usual method of design is to begin with the rotor radius, flux per pole, and ampere-conductors per inch of rotor circumference. The flux density in the air-gap is determined when the stator-tooth density and the ratio of slot pitch and tooth width are set. The depth of slot is determined by the ampere-conductors per inch, and the cir. mils per ampere. The depth of stator core and the stator radius then are determined by setting the value of the flux density in the stator core. The relations of the rotor and stator radius, the width of slot and tooth, the depth of slot and core, the flux per pole, and the flux density, to each other and to the motor performance are quite vague. Therefore, to determine their best proportions is difficult unless many experimental data are available.

In this paper an attempt is made to determine the relation of these factors to each other, and to determine their proportions for the best design. Briefly outlined, the analysis is presented as follows: The area of the stator slot is developed as a function of the shape of the slot, and the area occupied by the slot insulation. The effect of the slot insulation on the net area of the stator slot is taken into account by using a corrected value for the stator radius. The area of the wire used for stator coils is developed as a function of the flux per pole. The stator resistance is expressed as a function of flux per pole, and slot shape. The rotor radius is determined by setting the ratio of the flux densities in the core and teeth. A sample calculation is made using this method of design for motors of from two to twelve poles. The maximum torque as a function of the flux densities and of the flux per pole is discussed. The effect of stator resistance on maximum torque is calculated and shows that the flux per pole used should be very nearly that for minimum stator resistance. Fifty-three equations are developed. (**A. I. E. E. Paper No. 31 M 7**)

A-C. Networks in Portland, Oregon

By S. B. Clark[4]

ESSENTIALLY the full text of this paper was presented on pp. 644-647, ELECTRICAL ENGINEERING, August, 1931. (**A. I. E. E. Paper No. 31 M 2**)

The Mokelumne River Development of the Pacific Gas and Electric Company

By E. A. Crellin[5]

ESSENTIALLY the full text of this paper is published on pp. 705-12, of this issue of ELECTRICAL ENGINEERING. (**A. I. E. E. Paper No. 31-130**)

Power Transmission and Distribution from the Mokelumne River Development

By E. M. Wright[5] and B. D. Dexter[5]

ESSENTIALLY the full text of this paper is published on pp. 713-18, of this issue of ELECTRICAL ENGINEERING. (**A. I. E. E. Paper No. 31-131**)

Tie-Line Control of Interconnected Networks

By T. E. Purcell[6] and C. A. Powel[7]

OPERATING experience with tie-line load regulators on the Pittsburgh, Pa. tie line interconnecting the Colfax Power Station of the Duquesne Light Company with the Springdale station of the West Penn Power Company is described in this paper. Equipment used, including tie-line load regulators, program load control, and a hydraulic speed changer also is described.

The prime requirements of a successful tie-line load regulator are that it must not respond to small transient load changes, but that it must respond to small sustained changes. Further, it must respond to large load changes whether temporary or sustained.

The program loading equipment mentioned is installed at the Colfax station to maintain the most economical division of load between the various generating units of that particular station. The principle of dividing all load increments proportionally between units in a steam station does not necessarily make for maximum efficiency. In the program equipment at Colfax load scheduling is based on turbine valve position rather than on generator output, thus maintaining each turbine at its most efficient valve opening regardless of the effect of the many variables which enter into the position of the valve with reference to the load.

The new hydraulic speed-changing device described is intended to reduce to a minmum, wear on the governor parts, and to offset the tendency for increased wear arising from the extremely frequent governor operation imposed by frequency control.

As a result of tests made jointly by the Duquesne Light Company and the West Penn Power Company, the following conclusions are reached:

1. Tie-line load regulators and program loading equipment have been developed to a commercial stage.

2. Tie-line load regulators on one system can be operated satisfactorily in conjunction with frequency regulators on a connected system.

3. Tie-line control may be used to reduce load fluctuations between interconnected systems. (**A.I. E. E. Paper No. 31-127**)

Tuned Power Lines

By H. H. Skilling[8]

THE FULL text of this paper was published on pp. 634-37 ELECTRICAL ENGINEERING, August 1931. (**A. I. E. E. Paper No. 31-124**)

Intercontinental Radiotelephone Service from the United States

By J. J. Pilliod[9]

A COMPREHENSIVE abstract of this paper is published on pp. 748-52 of this issue of ELECTRICAL ENGINEERING. (**A. I. E. E. Paper No. 31-129**)

Electrical Solutions of Problems of Regular Scheduled Flight

By C. F. Green[10]

AN ARTICLE based on this paper was published on pp. 654-657 ELECTRICAL ENGINEERING, August 1931. (**A. I. E. E. Paper No. 31 M 3**)

The San Francisco-Los Angeles Section of the Pacific Coast Telephone Cable Network

By E. M. Calderwood[11] and D. F. Smith[12]

A COMPREHENSIVE abstract of this article is published on pp. 736-41 of this issue of ELECTRICAL ENGINEERING. (**A. I. E. E. Paper No. 31-125**)

Electrical Measurements of Sound-Absorption

By A. L. Albert[13] and W. R. Bullis[13]

PRINCIPALLY because of the recent development of high-quality radio broadcasting, group address systems, and sound motion pictures, the acoustic characteristics of buildings are now an important factor of architectural design. Using the work of Sabine and others as a basis, it is possible to design studios and auditoriums to give complete acoustic satisfaction.

However, since the sound-absorbing properties of various acoustic and building materials differ widely, it is necessary to determine quite accurately the sound-absorbing coefficients before reliable reverberation calculations can be made. These coefficients have been measured previously by various means, two of which are widely used. The first of these consists of covering the inner surface of a specially constructed room with the absorbing material to be tested. The sound-absorbing coefficients then can be calculated from the measured reverberation time. The other method is very similar except that instead of covering the surface of a room with the absorbing material, the material is placed on large panels in the room. Both of these methods as well as others which have been devised are accurate but necessitate the use of large test samples and are somewhat slow and expensive in use.

This paper describes an electrical method of measuring the sound-absorption properties of acoustic materials. Both the equipment and method can be said to be simple and rapid in operation, and inexpensive. With this method, the sound absorbing properties are determined by the effect produced on the electrical characteristics of a loud speaker by sound waves reflected from the absorbing material. The test equipment includes a relatively small wooden tube inside of which a loudspeaker with a special mounting may be moved back and forth with respect to the end of the box in which is mounted the sound-absorbing material to be measured. In addition to this equipment there is simply a vacuum-tube oscillator with a bridge measuring arrangement including the loudspeaker coil in one side of the bridge circuit.

Advantage is taken of the generally known fact that the electrical impedance measured between the terminals of a telephone receiver or loudspeaker is greatly affected by the location of the device with respect to reflecting surfaces in front of it. The effects of various sound-absorbing materials, as reflected through the adjustable loudspeaker device, are translated through the bridge readings into comparable figures which reveal the relative characteristics of different samples of materials. Although the tests which have been made and which are described in the paper indicate that this method gives consistent results, it is believed that the device can be made even more satisfactory and perhaps arranged to give the sound-absorbing coefficients directly as an indicating-instrument reading rather than from the impedance-bridge settings. (**A. I. E. E. Paper No. 31 M 6**)

Cathode Drop in Arcs and Glow Discharges

By S. S. Mackeown[3]

THE ARC is defined as an electrical discharge in a gas or a vapor in which the cathode drop is of the order of 10 or 20 volts and the current density to the cathode spot is of the order of hundreds or thousands of amperes per square centimeter. For an arc to exist it is necessary that there be some mechanism for producing electrons at or near the cathode. Unfortunately, there is no general agreement among physicists as to the mechanism which produces this low cathode drop with the correspondingly high current density which is characteristic of an electric arc. In this paper the author reviews briefly the different prevalent theories regarding the low cathode drop in an arc, offering discussions and interpretations based upon extensive research work carried out at the California Institute of Technology.

The author divides his subject treatment into four general parts: (1) the cathode drop in an arc, (2) the normal cathode drop in a glow discharge, (3) the abnormal cathode drop, and (4) transition from a glow discharge to an arc. In each case prevalent theories are briefly presented and discussed. (**A. I. E. E. Paper No. 31 M 5**)

The Kindling of Electric Sparkover Based on Lichtenberg Figures

By C. E. Magnusson[14]

THE MECHANISM of the electric sparkover process lately has become a much discussed problem. Townsend's theory of the formation of electric sparkover has been challenged and at least in some respects found wanting. Several well-known investigators have given ample evidence that the sparkover process is very complex; that the speed of formation is in the order of 10^8 cm. per sec. instead of 10^4 or 10^5; that polarity and shape of electrodes, ionization, space charges, voltage gradients air pressure, temperature, and other factors enter into the problem. The results of investigations on the early stages of electric sparkover throw light on certain phases of the initial or kindling stage of an electric spark formation, but a comprehensive explanation of the mechanism or process involved in the formation of electric sparks or sparkover still is lacking.

In this paper a new method of approach is described and experimental evidence is presented which tends to show that for *impulse sparkover* the following statements are valid:

1. Electrons are primarily the active elements in the kindling mechanism.
2. Lichtenberg figures form the initial step in the kindling process.
3. Sparkover develops from the tips of the positive Lichtenberg figures along the streamers of both the positive and the negative figures. (**A. I. E. E. Paper No. 31-123**)

Snow Surveys and Hydro-Forecasting

By H. P. Boardman[15]

A COMPREHENSIVE description of the apparatus and methods involved in a cooperative precipitation survey and the results obtained are given in this paper. The scope of the paper is limited principally to the watershed area of the eastern Sierra Nevada range of California, the runoff from which constitutes the chief source of water supply for Reno, Nevada, and environs. Statistical information is presented which reveals the accuracy of predictions based on snow surveys, as compared with actual runoff for various seasons. (**A. I. E. E. Paper No. 31 M 4**)

Radio Coordination

By C. C. Campbell[5] and H. N. Kalb[16]

THE AUTHORS' experience with radio-interference problems in northern and central California is used as a basis for this paper. An attempt has been made to present the various phases of the problem rather than to offer a solution of any particular phase. Radio interference from natural static and from radio sources is not within the scope of this paper, but is mentioned where it has a bearing upon interference caused by electrical sources. Natural static is less severe in the West than in the East, making other types of radio interference more apparent. A larger network of higher voltage transmission lines also has been built up in the West because of the extensive hydroelectric developments and a more scattered population, and this factor also enters the problem to some extent.

Variations of broadcast service area arising from station power and location and as affected by the topography of the surrounding country have been found to have an important bearing upon the radio-interference problem. Experience shows that there is no simple solution for the interference problem; that it must be dealt with in a spirit of cooperation by the utilities, the electric manufacturers, and the public. In the West, interference from electric power supply systems is well in hand except for the troubles originating on high-voltage lines. Although filters on power lines have been suggested, their use is questionable.

Manufacturers have a great opportunity in the sale of radio noiseproof appliances and apparatus, and the public can help by insisting upon such appliances. Increased broadcast coverage is very desirable to offset the maximum noise level in many of the large areas now having low field strengths. However, continued cooperative effort on the part of all concerned undoubtedly is the best solution to the interference problem. (**A. I. E. E. Paper No. 31-122**)

Calorimeter Measurement of Stray-Load Losses

By G. D. Floyd[17] and J. R. Dunbar[18]

THIS paper covers several thermal or calorimeter tests which were made at the Queenston generating station of the Hydro-Electric Power Commission of Ontario, on a 55,000-kva. generator having an enclosed system of ventilation. The objects of the tests were to determine stray-load losses on short circuits and under rated load, and to obtain some information regarding the accuracy of this method of test. Descriptions are given covering the general method followed and the actual tests as made. For those who might wish to check the calculations in detail the actual figures are given in an appendix.

The results of the tests show that the stray-load losses on large units can be determined with fair accuracy by this method when an enclosed system of ventilation is used on the unit. Tests also seem to show that the difference between the stray-load losses under load conditions and under short-circuit conditions is slight, and that a test under load conditions is justified only when an extremely accurate determination of losses is required. For most purposes a test under short-circuit conditions seems to be sufficient. (**A. I. E. E. Paper No. 31-126**)

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News

Of Institute and Related Activities

Bagnell dam and semi-outdoor power house of the Union Electric Light and Power Company (St. Louis) built by Stone & Webster Engineering Corporation

South West District To Meet at Kansas City

A VARIETY of interesting technical subjects, good entertainment and profitable inspection trips to noteworthy local engineering projects comprise the program for a three-day fall meeting of the South West District No. 7 to be held at Kansas City, Mo., Oct. 22-24, 1931. Headquarters will be at the Kansas City Athletic Club.

Nineteen papers will be presented in four technical sessions the first of which consists of a group of selected subjects: back-fires in rectifiers, surge tests on a distribution substation, overvoltages due to dropping of load, computing currents in networks and loops, building-construction welding, effect of wave form on relay operation, and pilot-wire relaying. The second session will be devoted to the St. Louis-Bagnell interconnection, with the showing of a motion picture description of the actual construction of the Bagnell dam. The third session will deal with communication subjects; economic surveys, advance planning of long distance telephone facilities, tape-armored cable, and the time factor in transmission. The closing session will be on subjects in the field of transmission and distribution, such as lightning field investigation, heat flow from cables, corona energy loss, fuses, and cut-outs.

The banquet Friday evening, October 23, will be held in one of the finest banquet rooms in the Middle West—that at the Kansas City Athletic Club, noted for its excellent cuisine. Between courses, entertainment will be provided by some of the best talent obtainable, and following the banquet there will be dancing with music furnished by an orchestra well qualified to please all.

Golf will be arranged for all those who may wish to play.

Women's Entertainment

Women attending will be entertained with a luncheon bridge at one of our golf clubs, a theater party, and shopping tours. Nothing will be left undone to make their visit to Kansas City a pleasant one.

Tentative Program

Thursday—a. m.

Registration
Opening address
Student technical session

Thursday—p. m.

(a) Student Session

(b) Session on Selected Subjects

Electric Arc Welding in Building Construction, P. N. Vinther, Dallas Power & Light Co.

The Effect of Wave Form on the Operation of Induction-Type Relays, P. H. Robinson, Houston Lighting & Power Co.

The Telegraphic Pilot-Wire Relay System, C. H. Frier, Oklahoma Gas & Electric Co.

Calculating Load Division in Distribution Systems, C. T. Almquist, The University of Oklahoma.

Back-fires in Mercury-Arc Rectifiers, J. Slepian and L. R. Ludwig, Westinghouse Elec. & Mfg. Co.

Overvoltages on Transmission Systems due to Dropping of Load, E. J. Burnham. General Electric Co.

Impulse-Voltage Tests on a 4,800-Volt Distribution Substation, H. W. Collins and E. E. Piepho, Detroit Edison Co., and J. J. Torok, Westinghouse Elec. & Mfg. Co.

Thursday Evening

St. Louis-Bagnell Interconnection

Interconnection of the 25- and 60-cycle Systems of the Union Electric Light & Power Co., E. L. Hough and L. V. Nelson, Union Elec. Light & Power Co.

Automatic Control for Variable-Ratio Frequency Converters, E. K. Shively, Union Electric Light & Power Co., and G. S. Whitlow, General Electric Co.

Three-Reel Motion Picture of the Actual Construction of the Bangnell Dam.

Friday—a. m.

Communication

Economic Surveys and Their Application to Engineering Problems, J. N. Holsen, Southwestern Bell Tel. Co.

Advance Planning of Long Distance Telephone Facilities, O. C. McFarland, Southwestern Bell Tel. Co.

Tape-Armored Telephone Toll Cable, C. W. Nystrom, Southwestern Bell Tel. Co.

The Time Factor in Telephone Transmission, O. B. Blackwell, American Telephone & Telegraph Co.

Friday—p. m.

Inspection trips and recreation

Meeting of board of directors

Friday Evening

Banquet and entertainment

Saturday—a. m.

Transmission and Distribution

Field Investigation of Lightning Disturbances on Transmission Lines, D. C. Jackson, Jr. and R. W. Warner, University of Kansas.

Heat Flow from Underground Electric Power Cables, L. J. Neuman, The Texas Co.

Corona Energy Loss, W. D. Weidlein, Black and Veatch.

Application of Primary Distribution Fuses, F. E. Sanford, Union Gas & Electric Co.

The Expulsion Fuse, J. Slepian and C. L. Denault, Westinghouse Elec. & Mfg. Co.

Fuse Cut-outs with Special Reference to Their Design and Application for A-C. Distribution Circuits, E. G. Newton, General Electric Co.

Saturday—p. m.

Inspection trips and recreation

Hotel Reservations

Reservations for hotel rooms should be made by writing directly to the hotel preferred. In the following table, rates are listed for the headquarters hotel, the Kansas City Athletic Club, and several other hotels conveniently located in the neighboring vicinity. Members of the Dallas, Houston, Oklahoma City, and Wichita Athletic Clubs may enjoy reciprocal relations:

New building of the Kansas City Power & Light Company features a 13,200/199/115-volt, three-phase, four-wire, vertical distribution system

Hotel	Hotel Rates: Single Rooms	Hotel Rates: Double Rooms
Kansas City Athletic Club	$3.00-$5.00	$5.00-$7.00
Baltimore	$1.50-$2.00*	$2.50-$3.00*
	$2.50-$5.00	$3.50-$6.00
Muehlebach	$2.50-$3.50*	$4.00-$5.00*
	$3.50-$8.00	$5.00-10.00
Phillips	$2.50-$4.00	$4.00-$6.00
Pickwick	$2.50-$4.00	$3.50-$6.00
President	$3.00	$5.00
Stats	$2.00-$3.50	$2.50-$5.50

*Rooms without bath

Committees

The personnel of the general committee consists of: G. C. Shaad, *chairman*, vice-president South West District; R. W. Warner, secretary South West District; S. T. Blaisdell; J. E. Busher; C. B. Fall; C. D. Farman; D. C. Jackson, Jr.; F. J. Meyer; J. S. Palmer; A. A. Rall. Subcommittee chairmen are: R. L. Baldwin, *hotels and registration*; M. M. Boggess, *finance*; D. D. Clarke, *technical sessions*; D. W. Ellyson, *golf*; G. Fiske, *entertainment*; A. L. Maillard, *inspection trips*; O. P. Minnick, *publicity and attendance*; F. L. Phillips, *transportation*; M. P. Weinbach, *student activities*.

Inspection Trips

Kansas City is the home of nearly every type of industry that can hold the attention of an engineer, especially electrical engineers. Some interesting features to be studied are the new supersynchronous motor installations for the cement mills, the completely automatic system of the Kansas City Power & Light Company, the application of electricity to the milling industry, for example the new automatic installations of the Southwestern Bell Telephone Company. Engineers interested in the application of electricity to water supply systems also will find Kansas City a capital place to study.

Grand Avenue Station

In 1927, the Kansas City Power & Light Company acquired the old Grand Avenue Station of the Kansas City Public Service Company (the street railway company). This plant which was first put in service in 1903 was antiquated and expensive to operate; however, the location made it not only favorable for central power production and distribution, but ideal as a production center for the continually increasing demand for central district steam heat. Upon the acquisition of this property, a rebuilding program was started which has extended over a four-year period and has involved the expenditure of nearly $6,000,000. The result has been the conversion of an obsolete inefficient station into a strictly modern, efficient, high-pressure power and heating plant. All central station men will want to review this rebuilt work and see how increased efficiency was brought about in so short a time.

Other Points of Interest

In addition to its two generating stations, Kansas City for its size probably has the most complete automatic power distribution system of any city in the United States, with all power except for 13.2-kv. primary service supplied from

substations equipped with complete automatic control. The system consists of two major parts: the d-c. substations, and city a-c. substations with outdoor a-c. suburban stations.

The d-c. system embraces a restricted district in the downtown business section, with d-c. network fed from five synchronous converter substations of two automatically controlled machines, each of which feeds an individual bus, being tied together only through the d-c. network.

The a-c. system consists of seven 13,200/4,400/2,550Y-volt, three-phase, four-wire automatic substations. These stations located in various parts of the city are architecturally designed to conform to the type of district in which they are located. Interior designs follow usual practise, but with such additional features as comply with latest ideas. Stations of interest in this group are: Substation *R* of residential type using reinforced concrete for switch barriers and regulator bays; Substation *A* of residential type using "Ha-dite" concrete barriers; and the latest Substation *H* located in a newly developed business and apartment district, with the station exterior designed to conform with the general architectural plan of the district. The interior design is in artistic agreement with the exterior. Special features of this station include switch structures and regulator bays of fabricated stone, all circuit breakers frame-mounted and not supported by the barriers, and a heating and ventilating system fully automatic in its operation.

A visit to the Bell Telephone building will afford an opportunity to inspect a large telephone power plant, a large telegraph repeater station, a panel-type dial central office, a large manual central office, toll and local operating rooms, etc. The Benton-Chestnut exchange which is to go into operation October 1, 1931 has the most modern type of dial equipment, together with associated operators' positions. This exchange has 16,500 terminal stations with an average of 120,000 originating and 117,000 incoming calls per day.

The committee has arranged a trip to the Bagnell water power project of the Union Electric Light & Power Company located in the center of the state. This trip, in addition to the fine papers on this subject, will give an interesting picture of this much discussed project.

Radio Newspaper.—A daily newspaper, specially prepared for radio facsimile transmission by the Schenectady *Union Star*, has been sent daily to ships at sea from General Electric's short wave station at Schenectady, N. Y., since July 30. The newspaper is compiled late in the afternoon to contain the latest news of the day, and is transmitted between 9 and 11 o'clock at night over apparatus developed by Dr. E. F. W. Alexanderson (F'20). At present reception of this radio newspaper is limited. Receivers have been installed by the Radio Marine Corporation on two transatlantic liners, the *America*, and the *Minnikahda*, and another is being operated in Doctor Alexanderson's department in the General Electric research laboratory, about 3 mi. from the transmitter. The receivers are known as the carbon facsimile recorders, developed a year or two ago by Charles J. Young, son of Owen D. Young.

Tahoe Convention To Be Reported

The Pacific Coast convention at Lake Tahoe, California, opened its sessions Tuesday morning, August 25, too late to be reported in this issue of Electrical Engineering. However, brief interpretative abstracts of all Tahoe papers may be found on pp. 753-56 of this issue.

The general news story covering convention activities will appear in the October issue. It is hoped also that the written discussion of Lake Tahoe papers will be in the hands of the secretary of the meetings and papers committee at 33 West 39th Street, New York, N. Y., in sufficient time and in sufficient quantity to warrant the presentation of a review of discussion in connection with the convention story in the October issue.

Directors Meet at Institute Headquarters

The regular meeting of the A. I. E. E. board of directors was held at Institute headquarters, New York, August 4, 1931. Present were: *President*—C. E. Skinner, East Pittsburgh, Pa. *Vice-presidents*—H. P. Charlesworth, New York, N. Y.; L. B. Chubbuck, Hamilton, Ont.; W. E. Freeman, Lexington, Ky.; W. B. Kouwenhoven, Baltimore, Md.; I. E. Moultrop, Boston, Mass.; G. C. Shaad, Lawrence, Kans. *Directors*—A. B. Cooper, Toronto, Ont.; J. E. Kearns, Chicago, Ill.; J. Allen Johnson, Buffalo, N. Y.; A. E. Knowlton, New York, N. Y.; A. M. MacCutcheon, Cleveland, Ohio; C. E. Stephens, New York, N. Y. *National treasurer*—W. I. Slichter, New York, N. Y. *National secretary*—F. L. Hutchinson, New York, N. Y.

The minutes of the directors' meeting of June 24, 1931, were approved.

Approval was given to a report of a meeting of the board of examiners held July 29, 1931; and upon the recommendation of that board, the following actions were taken upon applications pending: 18 Students were enrolled; 51 Associates were elected; seven Members were elected; 23 applicants were transferred to the grade of Member and two to the grade of Fellow.

Approval for payment by the finance committee of monthly bills amounting to $38,414.61 was ratified.

Authorization was given for the extension of territory of the Los Angeles and the San Francisco Sections in order to include the entire state of California between the two Sections.

The president announced the appointment of committees and representatives for the administrative year beginning August 1, 1931. (A list of committees and representatives appears elsewhere in this issue.)

As required by the by-laws of the Edison Medal committee, the board confirmed appointments to the committee made by the president as follows: D. C. Jackson, chairman for the year beginning August 1; E. B. Meyer, L. T. Robinson, and P. H. Thomas, for terms of five years each; C. E. Stephens to fill vacancy for the year ending July 31, 1932. Also, the board elected from its own membership to serve on the committee for terms of two years each, J. E. Kearns, W. S. Lee, and F. W. Peek, Jr.

In accordance with the by-laws of the Lamme Medal committee, the board confirmed the following appointments by the president: B. A. Behrend, A. M. Dudley, and J. C. Parker.

Local honorary secretaries reappointed for the two-year term beginning August 1, 1931, were: M. A. Chatelain, Russia; A. F. Enstrom, Sweden; A. P. M. Fleming, England; T. J. Fleming, Argentina; Renzo Norsa, Italy; P. H. Powell, New Zealand; F. M. Servos, Brazil.

Upon the recommendation of the standards committee, various subjects were referred for consideration to the electrical standards committee of the American Standards Association, and approval was given for publication as a report of the committee on electrical machinery for further study by those interested, of a proposed test code for transformers prepared by the electrical machinery committee.

Progress report No. 7 of the joint committee on welded rail joints, submitted by D. D. Ewing, A. I. E. E. representative on the committee, was received and ordered filed in the Engineering Societies Library.

The board voted to hold its next meeting in Kansas City, Mo., during the District meeting to be held in that city, October 22-24.

Other matters were discussed, reference to which may be found in this and future issues of ELECTRICAL ENGINEERING.

Faraday Centennial to be Held in London

TO COMMEMORATE the one hundredth anniversary of the discovery of electromagnetic induction in 1831 by Michael Faraday, who, blacksmith's son though he was, has come to be known as the "creator of the age of electrical power," the Royal Institution and the Institution of Electrical Engineers of London, in cooperation with other British scientific societies, are arranging a centenary celebration to be held September 21-23, 1931. Government and university bodies as well as other scientific interests also have joined hands in offering their cooperation and assistance to make the celebration worthy of the occasion.

The following tentative program has been announced by the institutions sponsoring the celebration:

Monday, September 21

Afternoon

Reception of delegates from representative institutions throughout the world in the lecture theater of the Royal Institution.

Evening

Faraday commemorative meeting at Queen's Hall during which addresses will be given on Faraday's work.

Tuesday, September 22

Morning

Summer meeting of the Institution of Electrical Engineers begins with joint conference of the Institution and allied associations.

Afternoon

Visits and social functions.

Evening

Royal Institution: Conversazione at the House of Institution.

Institution of Electrical Engineers: Conversazione and Faraday exhibition at the Albert Hall.

Wednesday, September 23

Morning

Opening of the Faraday exhibition to the public. I. E. E. summer meeting and conference continued.

Evening

Opening meeting of the British Assosociation at the Central Hall, Westminster.

At Asheville - - - in 1905

IN this group in attendance at the Institute's 22nd annual convention held at Asheville, N. C., June 19-23, 1905, were five some-time presidents of the Institute: T. Commerford Martin, 1887-8; Charles P. Steinmetz, 1901-2; John W. Lieb, 1904-5; Samuel Sheldon, 1906-7; and C. O. Mailloux, 1913-14. Of all these, Doctor Mailloux is the only one now living.

Honoring Faraday and his work, the program on Monday evening will include tributes by the British Prime Minister, the Rt. Hon. J. Ramsay MacDonald, the Duc de Broglie, Senator Marconi, Prof. Elihu Thomson, Prof. P. Zeeman, and other distinguished representatives of leading institutions throughout the world. The most outstanding feature of Monday night's program, however, will be the commemoration address by Sir William Bragg, who is one of Faraday's successors as head of the Royal Institution in London where the majority of the great scientist's experiments were carried out.

The entire commemorative meeting of Monday evening will be broadcast in England by the British Broadcasting Corp., while in the United States the National Broadcasting Company will rebroadcast a portion of the program between 4:00 and 5:00 p. m. eastern daylight saving time.

The exhibition to be opened on Wednesday has been arranged principally by the Institution of Electrical Engineers, and will be open to the public for a period of about ten days. The central feature of this exhibition will be reproductions and illustrations of Faraday's actual experiments, prepared by the Royal Institution, together with a display of some of his historic apparatus. Faraday's chemical and electrochemical work, which while not so well known as his discovery of electromagnetic induction nevertheless is hardly less remarkable, will be illustrated by means of special exhibits arranged by other cooperating societies.

Upon invitation of both the Royal Institution and the Institution of Electrical Engineers, the A. I. E. E. has appointed Dr. Wm. McClellan (F'12 and past-president) as its delegate to the celebration, and Dr. A. E. Kennelly (F'13 and past-president) as alternate.

Preceding the Wednesday morning opening of the Faraday exhibition, General Smuts, recently elected head of the British Association for the Advancement of Science, will deliver an address. On behalf of the other American societies who were invited to participate, Dr. F. B. Jewett (F'12 and past-president) then is scheduled to deliver brief felicitations by radiotelephone.

FARADAY'S DIARY TO BE PUBLISHED

Among the other many interesting features of the celebration comes the announcement of the publication of Faraday's diary, two volumes or more of which are expected to be ready by the time the celebration takes place. Faraday maintained a careful diary of all of his experimental work and this has been bequeathed to the Royal Institution and for over 60 years has been that organization's treasured possession. Although Faraday made extensive use of his notes in the preparation of his published works, the diary itself never has been published. As a permanent memento of the centenary celebration as well as of the man himself, managers of the Royal Institution have resolved to publish it in full.

Valuable Trophies Won in Summer Convention Sports

HEADLINER among the attractive sporting events offered at Asheville in connection with the annual summer convention of the Institute, June 22-26, 1931, was the annual tournament for the Mershon cup. Of chief interest in this connection is the fact that L. F. Deming (A'17) district engineer of the General Electric Company at Philadelphia, Pa., came into permanent possession of the Mershon trophy by virtue of his second winning of it. Mr. Deming won the first right to have his name engraved on the cup at the annual tournament held in connection with the summer convention at Cleveland, Ohio, in 1916. A beautiful silver tray also was presented to Mr. Deming as 1931 tournament winner by the Asheville convention sports committee. As runner-up in the Mershon tournament, R. O. Bentley (M'14) superintendent of the Public Service Electric & Gas Company, Newark, N. J., was presented with a beautiful silver bowl.

A silver bowl also was presented to S. K. Bushnell (A'22) Philadelphia sales manager for the Aluminum Company of America, for achieving low gross of 77 (par 71) in the qualifying round. A. H. Sweetnam (M'18) superintendent of the electrical engineering department of the Edison Electric Illuminating Company, Boston, also won a silver bowl for his low net of 60 (80-20) in the qualifying round.

In connection with the second round of the Mershon Cup event, a silver bowl was won by E. W. Dillard (A'16-M'30) electrical engineer for the New England Power Association, Boston, for his happy choice of 76 as a kicker's handicap (100-24). Tied with Mr. Dillard so far as net scores in this event were concerned, were R. A. Monroe (A'30) hydraulic engineer for the Aluminum Company of America, Pittsburgh, and G. A. Kositzky (M'22-F'29) chief engineer of the Ohio Bell Telephone Company, Cleveland. The prize was awarded by lot to Mr. Dillard.

For medal play handicap, two silver bowls were awarded, one to H. C. Don Carlos (F'18) chief operating engineer for the Hydro-Electric Power Commission of Ontario, Toronto, for his low gross of 82; and one to R. A. Monroe for his low net of 69 (84-15).

In the ladies' putting contest held on the 18-hole lawn course of the Grove Park Inn at Asheville, Mrs. W. K. Vanderpoel of South Orange, N. J., won first place and received a pair of silver bowls. As runner-up, Mrs. A. E. Bettis of Kansas City, Mo., won a silver plate.

In men's singles at tennis, J. K. Peck (A'27) assistant engineer for the National Electric Light Association, New York, came out best man receiving a silver bowl as his prize. As runner-up, E. F. Lopez (A'16-M'18) manager of the National Import Company, Mexico City, won a set of six silver ash trays.

Winners of Mershon Trophy

A. M. Schoen	1912
J. C. Mock	1914
E. W. Allen	1915
L. F. Deming*	1916
A. A. Brown	1919
M. G. Kennedy	1920
Howard Maxwell	1921
Philip H. Chase	1922
G. L. Knight	1923
R. O. Bentley	1924
C. E. Stephens	1925
H. C. Don Carlos	1926
A. H. Sweetnam	1927
W. C. Heston	1928
W. S. Lee	1929
Wills Maclachlan	1930
L. F. Deming*	1931

*Permanent possession gained by virtue of second winning.

Illumination Engineers Meet in October

The twenty-fifth annual convention of the Illuminating Engineering Society will be held at the William Penn Hotel, Pittsburgh, Oct. 12-16. Indications are that this convention will attract wide attention, several unusual additions having been made to the technical program, according to official announcement. There will be also a special program commemorating the society's silver anniversary.

Recognizing the present day importance of safety in night flying, the society has given over an entire session to the discussion of aviation lighting. Central-station lighting also will be given an important place on the program.

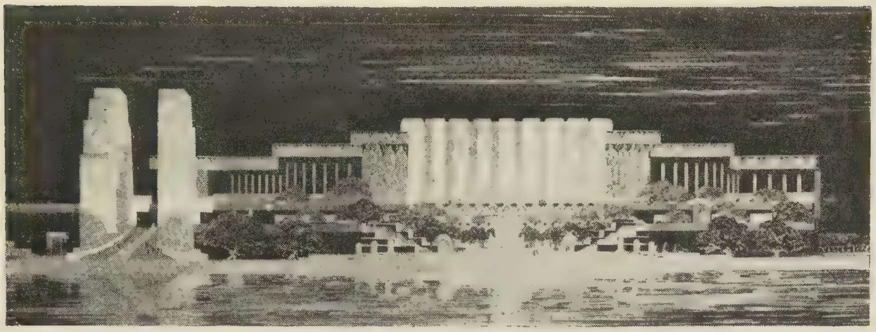
A. W. Robertson (A'27) chairman of the board of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, is chairman of the general convention committee, and J. A. Hoeveler of the Pittsburgh Reflector Company is chairman of the convention executive committee; P. H. Powers (M'30) vice-president of the West Penn Power Company and Joseph McKinley, vice-president of the Duquesne Light Company are serving as vice-chairmen. The committees in charge invite early registration by all who expect to attend.

Polish Engineering Secretary Visits U. S.

Joseph Podoski, secretary-general of the Polish Association of Electrical Engineers, spent the first two weeks of August touring the eastern portion of the United States in the interests of his organization. Mr. Podoski spent appreciable time acquainting himself with the policies and operating procedure of the American Institute of Electrical Engineers and the American Standards Association; he was interested also in electric power problems and railway electrification, spending several days visiting manufacturing plants and operating properties in an effort to gain a first-hand impression of American technique.

Mr. Podoski is one of the first Polish engineers to visit the United States under the reciprocal visiting membership privileges provided by action of the board of directors several years ago and recently extended to include the Polish Association of Electrical Engineers. Under this arrangement Institute headquarters in New York receives and forwards mail, upon presentation of proper credentials provides letters of

"A Century of Progress" Electrical Group



GROUND was broken Monday, July 20, 1931, for the Electrical Group, fifth building of Chicago's 1933 World Fair. The building was designed by Raymond Hood of New York, is 1,200 by 300 ft. in plan, two stories high, and of striking modernistic design employing a combination steel and special wallboard exterior; white, yellow, red, black, and blue are to be dominant colors. This structure will be embellished with hanging gardens and paved terraces, and will provide generous areas for the exhibition of generation, distribution, utilization, and communication equipment.

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introduction, affords a convenient meeting place for appointments, and places at the disposal of foreign engineers the resources of the Engineering Societies Library. Normally, these privileges are available for a period of three months, but are subject to extension for cause. Under the recently established arrangement members of the A. I. E. E. visiting Poland will receive full privileges from the Polish organization providing formal application is made through Institute headquarters in New York.

A. C. Langmuir Prize in Chemical Research Awarded

Dr. Linus Pauling, who at thirty has published nearly fifty papers in the field of pure science, and has won a full professorship in the California Institute of Technology, has been chosen as the first winner of the A. C. Langmuir prize of the American Chemical Society. The work of Pauling who will receive the award at the eighty-second meeting of the Society at Buffalo, September 2, has had to do with crystal structure, the quantum theory of the dielectric constant of gases, atomic and molecular structure, and determination of the nature of chemical bonds.

The Langmuir Prize, awarded for the first time this year, is bestowed "in recognition of the accomplishment, in America, of outstanding chemical research by a young man or woman preferably working in a college or university." It emphasizes, according to the announcement, the debt industry owes to pure science. "Outstanding chemical research for the purposes of the award," it stipulates, "is that which is of unusual merit for an individual on the threshold of his career in chemistry."

Dr. A. C. Langmuir, brother of Dr. Irving Langmuir, noted scientist of the General Electric Company, is an industrial chemist, teacher, and author, whose principal researches have dealt with shellac and glycerine. He first became interested in chemistry while a student at Irving Institute, Tarrytown-on-Hudson, setting up a small laboratory in his home. His experiments attracted the curiosity of his younger brother, who, with this as a starting point, has won worldwide fame in electrical research.

Secret Ray Light Applies Train Brakes.—An automatic stop system for trains, invented by Major Raymond Phillips of England, enables a person on the ground to apply the brakes and stop the train. All the person on the ground needs is a hand lamp that works a secret ray. When this light is thrown on an oncoming engine the ray works a special form of light-cell switch which applies the engine's vacuum brakes.—*Telegraph & Telephone Age, July 16, 1931.*

Photoelectric Cell Controls Street Lights

In Albany, N. Y., nine street lighting circuits are turned on automatically as soon as a certain predetermined degree of darkness occurs, regardless of the hour of the day. The photoelectric device which provides this automatic control is mounted on the roof of the Albany service building of the New York Power and Light Corporation, and is one of the first such control units to be placed in commercial service. As long as the predetermined degree of darkness prevails the device keeps the street lights in service, cutting them off upon the advent of sufficient daylight.

According to the General Electric Company "ultimately all the street-lighting circuits in the city will be operated by similar equipment . . . "

It is claimed that the photoelectric-tube device is more flexible and positive in operation than are time switches or manual operation. For example, during the 97 per cent total eclipse of the sun expected in 1932 Albany street lights probably may be expected to turn on automatically, as they also may upon very dark and stormy days. Further, seasonal changes will be taken care of automatically.

Arthur Wright, noted English consulting engineer and a pioneer in meter engineering, died in England, July 28, 1931, at the age of 73. A native of London, the first plan for him was to enter the medical profession; but he deviated from this course to take up electrical engineering, and as the first electrical engineer for the Brighton Town Council, installed the Portslade generating station. He was well-known in this country, visiting twice each year to instruct the employes of the Edison Electric Illuminating Company, Boston, in the latest developments of European engineering. As representative of the United States National Committee of the International Electrotechnical Commission, he attended the London meeting (1929) and the Stockholm meeting (1930) of Advisory Committee No. 2. Until six months ago, when his health failed, he was a member of the Institute which he joined in 1906 as an Associate.

Homer Eldredge Niesz, manager of industrial relations and vice-president of the Commonwealth Edison Company, Chicago, president of the National Safety Council and a member of its executive committee, died August 7, 1931, of peritonitis. He was 63 yr. of age.

Airplanes Carry South American Freight

A fleet of three G-31 Junkers planes of the Guinea Airways is reported as having been chartered primarily by the Bulolo Gold Dredging, Ltd., for hauling heavy mining equipment and supplies from the coast to their relatively inaccessible gold mines, and to carry back for export the precious metal itself. Each plane uses three 450-hp. air-cooled Bristol-Jupiter engines, giving a full-load speed of 115 mi. per hr. On a trial flight one of these planes carrying a 3.5-ton load of freight plus a crew of three and fuel sufficient for a flight of 1½ hr., climbed 7,500 ft. in 11 min. With one side engine cut out, the loaded freighter in 2 min. gained nearly 500 ft. of elevation.

Bucket dredges equipped with eighteen Westinghouse motors ranging in size up to 200 hp. each, switching equipment, and 200-kw. transformers are typical of equipment that has been flown the 32 mi. inland to the British New Guinea gold fields. Much shorter than the former circuitous water route, the air line hurdles mountains more than 2 mi. high.

American Engineering Council

Oil Pollution of Water Reported on Decline

Pollution by oil of coastal and inland waters in the United States is declining, it is indicated in a recent report of the American Engineering Council's joint committee on oil pollution.

Legislation to extend federal jurisdiction over waters which are under state control is opposed by the committee, of which Robert S. Weston of Boston, representing the American Society of Civil Engineers, is chairman.

"In reviewing the general problem of pollution by oil," the report declares, "the committee quite frequently has been confronted with the fact that one of the principal offenders in this connection is the United States Navy, which it is reported discharges oil from oil-burning warships without much regard for state or federal rules."

Replies to a questionnaire sent to sanitary engineers in 44 states show that pollution is believed to be decreasing in 25 states, and increasing in eleven. In six states the question was regarded with doubt. Of greater importance to the committee, however, is the fact that in 26 states the present state machinery was thought to be adequate to control the situation. In only twelve states was it felt that this machinery was inadequate.

House and Senate bills to enlarge federal authority are characterized by the committee as "most undesirable." These measures make it unlawful for any person to discharge oil by any means into or upon navigable waters, or upon any of the Great Lakes, their harbors or their connecting channels. Penalties are provided for violation of the law, the administration of which would be placed in the War Department.

Other members of the American Engineering Council's oil pollution committee, which was organized by G. T. Seabury of New York, secretary of the American Society of Civil Engineers, are: Abel Wolman, Baltimore, chief engineer of the Maryland State Department of Health, representing the American Society of Civil Engineers, secretary; W. H. Gartley, vice-president of the Philadelphia Gas Works Company, and W. C. Morris, New York, vice-president of the Consolidated Gas Company, the American Society of Mechanical Engineers; C. V. Weston, consulting engineer of the Chicago Surface Lines, and J. William Wetter, manager of Madeira Hill and Company, Philipsburg, Pa., the American Institute of Mining and Metallurgical Engineers; Dr. H. C. Parmelee, New York, editor of *Engineering News-Record*, and A. E. Marshall, Corning (N. Y.) Glass Company, American Institute of Chemical Engineers.

Personal

H. L. Doherty (F'13) according to recent disclosure through the columns of the society weekly, *Cleveland Town Tidings* (July 18, 1931) was the one who made financially possible the first floodlighting of the Statue of Liberty. George Williams, well remembered figure at Nela Park, conceived the plan and proposed it to the New York *World* which promptly approached Mr. Doherty, then associated with Mr. Williams, to underwrite the undertaking and promise to make good any deficit which might exist after all contributions were in. The *World* itself headed the list with $1,000 and 80,000 persons subscribed to the cause; not, however, until Mr. Doherty's promise of financial support had been obtained. The amount for which he ultimately gave his own check amounted to several thousand dollars. His part in the plan was pledged to obscurity, and neither his nor Mr. Williams's names were to appear in any publicity of the scheme. Since 1916 the true facts have remained a secret. Mr. Doherty's advance in the world of finances presents an interesting history. A news boy in the city of Columbus, Ohio, at the age of ten, he deserted that source of revenue two years later to become an office boy. By the time he was twenty he was manager of a public utility, and at thirty-five was a recognized leader in utility engineering and finance.

C. L. Dawes (M'15) has been advanced from the rank of assistant professor of electrical engineering to associate professor at Harvard University. Mr. Dawes has done much valuable research work in the insulation field, contributing considerable to technical literature in a series of articles "Ionization Studies in Paper-Insulated Cables" and others. He has held office on the N. E. L. A. cable research committee and the A. I. E. E. committee on dielectrics and subcommittee on definitions and terminology; is student counsellor and was a member of the A. I. E. E. committee on student Branches. He is a member of the National Research Council.

T. R. Langan (M'30) who has been assistant manager of the northeastern district of the Westinghouse Electric & Manufacturing Company, now has been appointed manager, with headquarters in New York City. Before going to New York, Mr. Langan served his company in Philadelphia, Baltimore, Buffalo and as manager of the Syracuse office. He has been active also on engineering committees of the A. E. R. A., was president of its Metropolitan Section in 1928 and for the past three years has been busy as a member of the subject committee of the New York Railroad Club.

W. F. James (M'20) formerly the Middle Atlantic district manager of the Westinghouse Electric & Manufacturing Company, has been appointed assistant to the commercial vice-president of the Atlantic Division of that company. He has been a member of the Westinghouse organization since 1909. Mr. James is a past-president of the Electrical Association of Philadelphia and of the Engineers Club of Philadelphia, a member of the industrial relations committee of the Philadelphia Chamber of Commerce, and a member and past regional vice-president of the A. I. E. E.

R. J. WENSLEY (A'28) creator of the televox, first of popular mechanical robots, has been transferred from the East Pittsburgh engineering department of the Westinghouse Electric & Manufacturing Company to the company's meter department at its Newark works. Mr. Wensley has done notable work in connection with switchboard and automatic switch design and is a recognized authority in the field of intricate electrical control equipment. During 1929 he served on the A. I. E. E. subcommittee on automatic substations.

G. I. WRIGHT (M'28) in charge of electrification for the Reading Company (Philadelphia) since 1927, on May 16, 1931 was made its chief electrical engineer in charge of all electrical and signal engineering. Mr. Wright, who at one time was assistant electrical engineer of the Illinois Central Railroad Company, continues as a member of the A. I. E. E. transportation committee. His new appointment is largely in recognition of the capacity he has shown in the work.

D. C. JACKSON, professor of electrical engineering at Massachusetts Institute of Technology recently received the annual Lamme Medal award of the Society for the Promotion of Engineering Education, presentation being made at the annual convention at Purdue University, Lafayette, June 17, 1931. This award is made "for accomplishment in technical teaching or actual advancement of the art of technical training."

H. E. M. KENSIT (M'08) after nearly twenty years in the Dominion Civil Service, retired August 1, 1931, to engage in private practise. His investigations and construction work in the United States and Canada included a detailed investigation of The South Saskatchewan Water Supply Division Project, involving comparative costs from all available power sources; water, steam, gas, and oil.

E. W. LOOMIS (A'19) who a few years ago was advanced from manager of the mill and mining section of Westinghouse Elec. & Mfg. Company to manager of the company's northeastern industrial division, now has become Middle Atlantic district manager with headquarters in Philadelphia, Pa.

T. C. MCFARLAND (A'22) who for the past year has been doing special work in engineering at the Bell Telephone Laboratories, Inc., New York, now has returned to Berkeley, Calif., to resume his duties as associate professor of electrical engineering at the University of California.

R. G. MEYERAND (A'28) who has been serving the Stone & Webster Engineering Company (Boston) as assistant to the chief electrical engineer, has been appointed sales engineer of the Rockbestos Products Corporation, New Haven, for its New England territory.

W. S. RICHHART (M'13) manager of the light and power department of the Indiana Service Corporation, Fort Wayne, Ind., one of the Insull properties, now has assumed charge of the distribution service of all Insull properties included in the Midland United Company.

W. M. HERBRUCK (A'25) formerly with the engineering department of the Ohio Power Company, Canton, Ohio, now has the position of chief electrical inspector for the American Electric Switch Corporation, Minerva, Ohio, still retaining residence in Canton.

K. B. THORNTON (M'13) who for a number of years, has been serving the Canadian Electric Railway Association at a recent meeting in Ottawa was elected president, the highest honor that can be conferred upon an electric railway operator in Canada.

W. S. GIFFORD (A'16) president of the American Telephone & Telegraph Company, New York, N. Y., was elected a member of the American Philosophical Society at its recent annual meeting held at the University of Pennsylvania, Philadelphia, Pa.

A. B. DAY (M'16) president and general manager of the Los Angeles Gas & Electric Corporation recently was elected president (1931-1932) of the Pacific Coast Electrical Association, in which he has been actively interested for several years.

O. K. MARTI (M'27) formerly chief engineer of the American Brown Boveri Co., Inc., Camden, N. J., is now associated with the Allis-Chalmers Mfg. Company in Milwaukee, Wis., as engineer in charge of rectifiers and railway equipment.

L. B. ANDRUS (F'19) president of the Indiana Electric Corporation, and a Life Member of the Institute, has been chosen by the National Electric Light Association to assume the presidency of its Great Lakes Division for 1931-1932.

W. E. GUTZWILLER (A'30) until recently electrical engineer for the American Brown Boveri Co., Inc., Camden, N. J., has moved to Milwaukee, Wis., to take a position in the rectifier department of the Allis-Chalmers Mfg. Company.

A. S. BROWN (A'30) instructor in the electrical engineering department of the University of Kansas, Fayetteville, Ark., until September 1 then became graduate research assistant, Kansas A. & M. College, Manhattan, Kansas.

E. H. MORRIS (A'23) for many years chief engineer of the Board of Railroad Commissioners, State of North Dakota, recently was appointed chief engineer of the Public Service Commission of West Virginia, Charleston.

G. T. HARNESS, JR. (A'30) will serve in the capacity of assistant in E. E. at California Institute of Technology, Pasadena, on leave of absence from the College of the Pacific to work for his Ph. D. degree.

T. A. FAWELL (M'20) formerly connected with the San Francisco office of the Marwood Company of California, Ltd., has been appointed manager of the Los Angeles office of that company.

R. C. MARSHALL, JR. (M'19) who has been serving the Sumner Sollitt Co., Chicago, Ill., as president, is now vice-president in charge of the B-W Construction Company, also of Chicago.

R. D. BEAN (A'21) who was manager of engineering development for the Brown Instrument Company, Philadelphia, is now chief engineer of that company.

President C. E. Skinner is the appointed representative of the American Standards Association on the council of the International Standards Association.

Obituary

William E. Richards (A'14-F'26) superintendent of electrical distribution for The Toledo Edison Company, Toledo, Ohio, died suddenly in his office August 12, 1931. He was born at Waynesburg, Ohio, October 20, 1863. In the early eighties he installed and operated an electric light plant for the Thompson-Houston Company at Newton, Iowa, and in 1891 returned to Ohio in responsible charge of electrical and mechanical operations for the Consolidated Street Railway Company, the various organizations of which occupied him until his death. Many of the advances of the Toledo Edison system were pioneered by him; he also planned and installed the flood-lighting system in the Statue of Liberty, receiving therefore a gold medal from the City of New York.

Besides his membership in the Institute, Mr. Richards was a member and an active worker in the Toledo Chamber of Commerce, The Edison Association, the National Electric Light Association, the Illuminating Engineering Society, the Ohio Good Roads Federation, and several other local organizations, professional and social. He was at one time chairman of the Institute's Toledo Section. Endorsing his transfer to the grade of Fellow of the Institute, J. B. Taylor (F'14) consulting engineer, General Electric Company, stated in 1925 that "Mr. Richards has met and solved many special problems in the distribution of power, both d-c. and a-c., at low and high voltage. Resourcefulness and ingenuity exercised over a long term of years gives him a unique position in the central station field."

Alva C. Dinkey (A'97) former president of the Midvale and Carnegie steel companies, and a pioneer in the steel industry in Pennsylvania, died at his home August 10, 1931, after a three-months' illness. He was sixty-five years old, and a well-known figure in the great steel activities of the country, having been engaged in the steel industry since beginning work in the Edgar Thomson Steel Works at the age of thirteen. He became president of the Midvale Steel and Ordnance Company, later the Midvale Steel Company, in 1915. His interest was largely in the electrical end of the steel industry, and throughout his life he was a close friend of Charles M. Schwab. Mr. Dinkey was a member of The American Society of Mechanical Engineers, the Society of Naval Architects and Marine Engineers, the Engineering Society of Western Pennsylvania, the Engineers Club of Philadelphia, the American Association for the Advancement of Science, and the Academy of Natural Sciences. He also held membership in the Racquet, Manufacturers, Sunnybrook, Five O'Clock (Philadelphia) Duquesne (Pittsburgh) clubs and the Indian House and Pennsylvania Society of New York.

George Gault Cree (A'22-M'30) of the central station engineering department General Electric Company, Schenectady, was drowned in Lake Ontario July 20, 1931. He was attending camp and had gone for a sail with a number of the company's officials, when a violent squall capsized the boat. Mr. Cree, who was not a strong swimmer, sank and exhaustive effort failed to reach him. Born in Scotland in 1888, he was educated in English and Scotch schools, and entered the General Electric Test course at Schenectady in 1919. After a number of years abroad he entered the central station engineering department where his experience and personality won the confidence of the utilities with which his work brought him in contact. He was a member of the N. E. L. A. apparatus committee, and of late had become prominent in local Boy Scout movements.

Bruce Ford (A'11) until recently general manager of the Electric Storage Battery Company, Philadelphia, of which he also was vice-president, died at his home near Philadelphia, August 10, 1931, after a brief illness. He was born in Brooklyn, N. Y. in 1873, and had been in the organization of the Electric Storage Battery Company since 1890, except for a few years in the early part of his career. More than fifty patents on inventions relating to storage batteries are registered in his name. Mr. Ford was a director of the Chloride Electrical Storage Company, Ltd., Manchester, England, and a member of the American Society of Mechanical Engineers, Franklin Institute, the Engineers Club (New York and Philadelphia), the Philadelphia Cricket Club, the Old Colony Club, and the Military Order of the Loyal Legion.

Lewis Judson Wells (A'24) sales engineer for the Diamond Electrical Manufacturing Company, Los Angeles, Calif., was killed in an airplane accident July 16, 1931. He had been with this company and its affiliated organizations since graduating from the California Institute of Technology in 1922. An interest in the art of flying led him to spend most of his leisure hours in the air.

Addresses Wanted

A list of members whose mail has been returned by the postal authorities is given below, with the address as it now appears on the Institute records. Any member knowing of corrections to these addresses will kindly communicate them at once to the office of the secretary at 33 West 39th St., New York, N. Y.

Bunce, Lewis I., Rocky Hill, Conn.

Clark, Bernard, 79 Jenness St., East Springfield, Mass.

Cole, Will G., Box 222, Westwood, Calif.

Corriveax, F. M., General Electric Co., Schenectady, N. Y.

Deacon, L. O., 6 Ailsa Ave., East Malvern, Melbourne, Australia.

Furui, Shungo, Shibaura Engineering Works, Tokyo, Japan.

McLean, James S., 190 Old Army Road, Scarsdale, N. Y.

Melson, Sydney W., Yeatton Woolwich Road, Abbey Wood, London S. E. 2, England.

Mountain, C. E., Burma Elec. Supply Co., Mandalay, Burma, India.

Nuber, Frank J., 3831 Rokeby St., Chicago, Ill.

O'Shea, V., Jr., 115 Broadway, New York, N. Y.

Pistorius, L. H., 193 Jeppe St., Johannesburg, South Africa.

Prudham, W. M., 100 Biddle St., Wilkinsburg, Pa.

Schrock, John E., 3720 Main St., Lawrence Park, Erie, Pa.

Sullivan, John E., 6320 Kenmore Ave., Chicago, Ill.

Tate, William, Apartado No. 41, Puebla, Mexico.

Tung, C. T., c/o Stone & Webster Engg. Corp., Hopewell, Va.

Letters to the Editor

Has Man Benefited by Engineering Progress?

Apparently the first article of The Engineering Foundation's symposium, concerning the possible benefits accruing to and through mankind as a result of engineering progress, as published in the August issue of ELECTRICAL ENGINEERING (C. E. K. Mees, p. 642) has appealed to different people in different ways. Among the letters received by the editors are the following:

To the Editor:

Doctor Mees's article, "Has Man Benefited By Engineering Progress?" in the August issue, is a refreshing contrast to the average engineer's blind worship of mechanical progress. It is as pleasant as it is unusual to find an eminent technician free from the common error of identifying industrial with human progress.

If in accordance with Doctor Mees's definition, engineering is taken as embracing all of applied science, its development, particularly in the field of medicine, has certainly been of notable benefit to mankind. The gain is small, however, in comparison with the benefits which would result if progress in the subjective elements of civilization kept pace with technological advancement. That it has not done so is of course a truism. Moreover, the inability of men to cast off superstition in their emotional and social life as fast as they discard it in dealing with the mechanics of existence is fraught with the gravest menace. Machinery merely amplifies the capacity for evil of the stupid and sadistic herd and its leaders. "Against stupidity," said Schiller, "the gods themselves fight in vain." Give to stupidity or ferocity modern machine guns and automobiles, and the gods might as well retire from the conflict altogether. It looks at times as if they have already done so.

For all this the engineers are as much to blame as educators, priests and magistrates. The very success of the engineering profession places on it some measure of responsibility for the misuse of its implements. The engineer is both too proud and too humble. He is too proud, because, unlike Doctor Mees, he seldom apprehends the narrowness of his contribution. Because of the feeling of power he derives from it personally, he comes to regard it as an end in itself. He is too humble, because he will not even raise his voice in protest against the perversion of his creations. He is like a designer of firearms who having created a particularly neat and powerful engine of destruction, puts it into the hands of a chimpanzee and goes on his way rejoicing.

The stability of society is at least as important as the stability of an electrical distribution system; but as long as this attitude is general, there is no hope of curing the fundamental evils of communal life. On the contrary, blind industrial proliferation will merely increase our hazards and the extent of our failure. Both the lowly and those high in power are uneasily conscious of the inability of mankind to adapt itself to the complications of the Machine Age. The principal burden of shame is on the successful and the competent. It matters little to the individual whether he starves because there is not enough food in the world, or too much. But the latter condition is much more disgraceful to society than the former.

There is perhaps nothing that the engineer, as a highly specialized helot of business, can do in an immediately practical sense, but it is encouraging to see him begin to think along the lines of the forthcoming series of papers. He may learn that the proper study of mankind is man, and not merely transmission lines, circuit breakers, and car couplings. He may be forced to acknowledge that, at the present stage, psychiatry and the social sciences are more important than further progress in engineering, and if he is somewhat humbled in his own estimate of himself, it may increase his usefulness in the long run.

Sincerely yours,
CARL DREHER (A'23)
(Director, Sound Dept., R. K. O Studios Inc., Los Angeles)

To the Editor:

You have asked for comments on the article, "Has Man Benefited By Engineering Progress?" by Dr. C. E. Kennedy Mees. It would require a rather extended discussion to refute Doctor Mees's beliefs. It is undoubtedly true that one's judgment on the influence of engineering progress on human welfare will depend upon the definition or assumption of the meaning of the term benefited. It seems to me that Doctor Mees has given an exceptional narrow meaning to this term. I believe the term human welfare, as used in the preamble of the Constitution of the United States, comes nearer expressing living conditions that have been influenced by engineering progress.

If we consider the contributions of engineering progress toward the fulfillment of the aims specified in the preamble of the Constitution, there is no doubt in my mind but what engineering progress has done more to promote the general welfare and to secure the blessings of liberty to ourselves and our posterity than all the philosophies written since Aristotle.

Doctor Mees asks the question, "will any student of history agree that the inhabitants of an American city are any happier on the whole than those of the Greek or Babylonian cities of the past?" The degree of happiness is incommensurable. If we substitute for happiness, welfare, I have no hesitancy in stating emphatically that the inhabitants of an American city have on the whole a much higher state of well being than the majority of the inhabitants of the Greek or Babylonian cities. It is useless to deny that the Greeks developed a high state of culture, but that culture was merely a crust superposed upon a state of society which today would not be tolerated even in a semi-civilized community. In so far as advancing the civilization—that is, improving the social conditions of the masses—of its own period is concerned, the philosophies of Greece and Rome did no more than the pyramids of Egypt or the palaces of Peru. Human progress was not arrested because ancient civilizations fell, but the civilizations fell because human progress had been arrested.

Doctor Mees still has the privilege of walking a short distance. At the same time he can ride a long distance if occasion demands, and on the way he may acquire by such experience an appreciation of life in remote regions. All of life and culture is not confined to a garden. The emotions aroused by the majesties of the Grand Canyon and of the snow-capped mountains are just as cultural as those aroused by a poem, a book on philosophy, or a growing radish. They are, however, beyond the confines of a garden and beyond the limits of a short walk. Likewise, Doctor Mees still has the privilege of attending to his business in a leisurely manner, to live in a small city, to cultivate a small garden, but I see that he lives in Rochester, New York. Assuredly, then, the attractions of a large city are more alluring and satisfying than living in a small city.

Very truly yours,
C. M. JANSKY (A'06)
(Professor of Electrical Engineering, University of Wisconsin, Madison)

To the Editor:

A few comments on the article, "Has Man Benefited By Engineering Progress?" by Doctor Mees.

Perhaps it would be well to think of the advancement of modern life as a series of tedious climbs from one level to another with resting places along the way.

It is apparent that mankind has been advancing rapidly and fighting feverishly to maintain a higher level of living for the past decade. Without the equipment of life sufficiently perfected to hold the level, so that the accomplishment has been made with a sacrifice of human happiness.

It is quite apparent that the equipment necessary to the security of such a level has been satisfactorially perfected at this time; and that the plane of life can now be maintained, through its application.

The necessities of life can be abundantly supplied with the available equipment and with a very effective decrease in man hours that will occur when economic conditions are fully understood.

There is little to fear in the form of revolution, though at this time, such a turn might seem inevitable.

This new level of life with its new standards of living was arrived at rapidly and we do not yet know how to curtail its productivity without injuring human happiness. Though we know man hours must be decreased materially.

The solution slowly evolves as Engineering applies the Science of Economics.

Yours very truly,
ORRIN S. VOGEL (A'29)
(Electrical Engineer, Georgia Power Company, Atlanta)

To the Editor:

Dr. Mees, in the August issue of ELECTRICAL ENGINEERING, takes a very pessimistic view of engineering's contribution to human progress, and I should like to present a point of view that will lend a little more rosy tint to the accomplishments of science and its handmaiden, engineering. We all realize that points of view are many and are usually taken by choice according to the temperament of the chooser. It must be confessed that between two views equally rational and consistent with the facts of history I should choose the more optimistic.

The yardstick by which I should measure the progress of the world is *consciousness*. Of course there are many definitions of the term and much will depend upon which definition is chosen. The sense in which I wish to use it, is the very broad one which includes both intellectual and emotional knowledge. For a further interpretation of this concept we might give as one reference the books of Prof. Warner Fite. To increase consciousness seems fully as fundamental an aim or purpose of mankind as any mentioned by Dr. Mees, even in its narrowest sense.

Life from the very beginning can be interpreted and explained in terms of such a measure very remarkably. The discoveries of speech and writing are the very foundations of the human race as we know it, and it is reasonable to suppose that progress in the future will be the result of other such remarkable discoveries. A return to the state of the contented cow can be justified on many grounds, but not on the ground of increasing consciousness. Is it not proper to value the forces that have made us

and look for their continuance in estimating progress?

Let us for a moment attempt to evaluate science in terms of increasing consciousness. Many of the results of science sink away into nothingness; for example, those things which create mere comfort and draw people from, rather than to, an active life. The great achievements, not always without pain and discomfort to many, appear as those that have added to better communication, recording, and understanding. Photography, wireless telephony, talking pictures, better transportation, cheaper books and magazines, and, in the realm of pure science, the new understanding of the universe and of the need for higher dimensions. These are the things that are going to lead to a race as much higher than we, as we are higher than the cave man.

It is true that engineering has been concerned almost entirely with material things, and in so far as it is limited to them it is insufficient; however, no one but an engineer will say that engineering is the whole of life. Owing to the spread of an artificial scientific attitude, religious fervor and spiritual awakening may even have suffered temporary setbacks, but how much greater will they be when man turns the instruments he is as yet just beginning to discover in the direction of things immaterial; immaterial yes, but more lasting and more powerful in human good than anything now imagined.

Yours very sincerely,

W. C. JOHNSON, JR. (A'29)
(Electrical Engineer, Industrial Engineering Dept., General Electric Co., Schenectady, N. Y.)

Employment Notes

Of the Engineering Societies Employment Service

Men Available

ELECTRICAL ENGINEER, 1930 graduate, 25, single. Eight months' construction experience; one summer with public utility, one year G. E. Test including six months on vacuum tubes. Eastern location preferred. Interested in any position except sales. Available on short notice. C-9591.

ELECTRICAL ENGINEER, 36, married, 18 years' experience on power plants, transmission lines, substations, switchboards, telephones, mine electrical equipment, motors, lighting, marine electrical work, draftsman. Five years' electrical engineer wiring for power, light, telephones, signal systems, elevators for all types of buildings. Also expert plumber, heater and tinner. C-9348.

1931 ELECTRICAL ENGINEERING GRADUATE, age 25. B. S. E. E. in well-known engineering college. Desires work in any of the following or similar classes: industrial control, research, radio, test, design, development or maintenance. Worked through school by alternating years at school with years at work. Excellent references. Industrial experience. Honor student. C-9518.

MANAGER, SUPERINTENDENT, RESIDENT OR OPERATING AND MAINTENANCE ENGINEER, technical graduate, B. S. in E. E., 22 years' experience, engineering, construction, operation and maintenance of steam, hydro and Diesel power stations, transmission and distribution systems, as well as special process and heavy mechanical equipment and industrial plants. C-9597.

ERECTING ENGINEER, 46, of broad experience in power plant construction, maintenance, and operation. Exceptional ability in the erection and wiring of switchboards, power plant auxiliaries, oil circuit breakers, and high-voltage outdoor substations. Available immediately. C-8792.

ELECTRICAL ENGINEER, 32, married, 8 years in iron and steel works, oil fields, etc.; electrical installation and maintenance. Three years central and substation electrical plant installation. Five years electrical drafting of rolling mill, coal mines, and public utility electrical plant. Anywhere United States or abroad. C-625.

1931 ELECTRICAL GRADUATE, midwest university, 22, single. Tau Beta Pi student. Desires connection with manufacturing or public utility concern. Location preferred, Middle west. C-9398.

ELECTRICAL CONDENSER ENGINEER with thorough knowledge and extensive experience in the design and application of impregnated paper, mica, and air dielectric condensers. Would like to organize or reorganize condenser department for reliable manufacturing company. Will present convincing details on receipt of correspondence. C-7970.

ELECTRICAL ENGINEER, specializing for the past four years in research and development work on hot-cathode neon arc lamps a-c. and d-c., low-voltage neon sign tubes, photo cells, mercury-rare gas, ultra-violet tubes. Desires to connect with company developing rare-gas arcs for television projection. C-9598.

GENERAL ENGINEER, primarily electrical, 37, countrywide experience with largest engineering and construction corporations. Responsible charge utility and industrial design, application, study, report, appraisal, operation and superintendence of construction. Successful contacting clients and handling men. Experienced in mechanical and structural practises. Now employed. Interview at Boston or New York. C-9627.

GRADUATE ELECTRICAL ENGINEER for shop supervision, research or development. Six years' shop, assembly and test. Twelve years design high-voltage out-door equipment. Knows shop tools by actually serving in shop. Has inventive ability, pleasing personality, and knows men. Age 40, married, now in Middle-West. C-9641.

ELECTRICAL ENGINEER, 24, single. Degree B. S. in E. E., Marquette '31. Three and one-half years' cooperative work in large manufacturing plant. Four years' housewiring experience. Location, Middle West, preferably Milwaukee. C-9642.

ELECTRICAL ENGINEER (Cornell), well known in South Africa for many years, and having an established engineering business in Johannesburg, seeks agencies for American electrical apparatus and supplies suitable for mining and industrial uses. C-9657.

ELECTRICAL, RADIO ENGINEER, 31, graduate with B. S. E. E. University of California. Experience in electrical and mechanical design, test and operation of radio and high-frequency circuits, apparatus. Experience in design and development of heavy power automatic switchboards and gang switches. Excellent references. Location preferred, New York. Available at once. C-6734.

ELECTRICAL ENGINEER, graduate of Lehigh University, 1930, age 25, one year on general test crew of large Pennsylvania Utility company. Mechanical and electrical experience. Three months for telephone company as student engineer. Can come for interview promptly. All references desired. C-9659.

ELECTRICAL ENGINEER with years of sales experience in the Middle West desires connection with headquarters preferably in Cleveland. University graduate in E. E. knows selling and advertising of technical products thoroughly. Would be excellent representative for growing manufacturer or publisher. B-8614.

MANAGER, electric light properties, 39, Protestant, married, 15 years' experience, sales, public relations, line-building, operation, maintenance, costs, franchise work, meters, transformers, accounting, billing, collections. District manager for property having 75 employees; sold out own property in Minnesota. Desires similar or departmental position anywhere; preference Middle West. Available immediately. Salary secondary to opportunity. C-9670.

COMMUNICATION ENGINEER, 31, single. Experienced telephone, radio installation; design, development of testing equipment for telephone, radio, sound-picture circuits; design, use of semi-, full-automatic testing circuits to eliminate human element in testing; industrial applications of photoelectric cells, thermionic tubes. Best references as to professional ability, personal integrity. Location, immaterial. Available immediately. C-9376.

ELECTRICAL ENGINEER, graduate eastern university, 1930 member honorary society, Iota Alpha. Ten months' experience Westinghouse Test on distribution and instrument transformers commercial tests and phase-angle measurements. Also in testing department, large public utility for a summer on engineering tests. Desires position in engineering field with opportunity. Location, immaterial. C-9564.

CENTRAL-STATION DESIGN ENGINEER, 33, graduate M. I. T., eight years' experience covering complete engineering design of generating stations, high-voltage switching stations, substations and transmission lines; including estimates, specifications, and purchase of equipment. Experience includes 18 months on the G. E. Test course and one year in the field. Married. C-4338.

ELECTRICAL DESIGNING ENGINEER, 25 years' experience with public utilities and industrial companies, power house and substations, steam and hydroelectric, copper ore and nitrate ore reduction plants, married. Seeks permanent connection, responsible position, anywhere in United States and Canada. New York State P. E. license. B-7031.

ELECTRICAL ENGINEER, 28 married, 1924 graduate of recognized technical college with degree of E. E. Three years' experience with large metropolitan public utility in charge of relays and system protection. Three years' experience in electrical laboratory investigating and testing all types of electrical devices. Location preferred, New York City or vicinity. B-8793.

EXECUTIVE ENGINEER (M. I. T. electrical post graduate degree). Fifteen years' experience with metropolitan power companies, large electrical manufacturer and in aeronautic test, design, research and construction. Extensive knowledge. Good leader with initiative. Will travel. B-1041.

ERECTING ENGINEER, 46 broad experience in power-plant construction, maintenance and operation. Exceptional ability in the erection and wiring of switchboards, power plant auxiliaries, oil circuit breakers, and high-voltage outdoor substations. Available immediately. C-8792.

ENGINEER, age 27, B. S., three years and seven months C. E. experience. Desires position with hydroelectric project. Qualified for chief of party, transitman, estimator, assistant engineer. C-9382.

ELECTRICAL ENGINEER, over 17 years' experience in light and power field, several years in charge of work, desires position in charge of electrical engineering work for central station company, either with or without construction and operating duties. University graduate, good technical knowledge, and ability to handle men. B-1923.

1928 GRADUATE ELECTRICAL ENGINEER, age 24, General Electric Company over two years, including one year test on power and control apparatus and one year laboratory development and measurement. Desires position with industrial company or with scientific school. Prefers Philadelphia or New York. C-9683.

SENIOR ELECTRICAL ENGINEER, 35, married. Considerable experience in projection and complete design of mills, power plants, distribution and other industrial phases. Some development experience. Urgently in need of placement. B-3172.

RAILROAD ELECTRICAL ENGINEER, six years varied design, construction, operating experience large western and eastern railroad electrifications; familiar with American, European practise regarding transmission lines, substations, catenary systems, motive power. American, college graduate, good references. A. I. E. E., A. S. M. E., A. R. A., AEREA. membership. C-8463.

GRADUATE ELECTRICAL ENGINEER, B. S. in E. E., 1931. Single, 25. Courses taken include design, radio, and telephone.

Slight knowledge of Spanish and German. One year's experience with electrical prospecting company. Desires position with any manufacturing or engineering concern. Location and salary secondary, opportunity and experience being main factors. C-9692.

1931 GRADUATE ELECTRICAL ENGINEER, age 22, married. B. S. in E. E. from Pennsylvania State College. Three months' experience as assistant engineer with telephone company and two months in system operating department of large power company. Desires position with utility, engineering, or manufacturing concern. Location, immaterial. References. Available immediately. C-9695.

VALUATION ENGINEER, graduate of technical school of standing with B. S. E. E. degree, 29, married. Over five years' experience in appraisal and financial work for public utilities. Desires position with consulting engineer or with banking or investment company dealing in utility securities. Present unemployment due to a merger. Available immediately. C-9700.

ELECTRICAL ENGINEER, B. S. degree 1929, single, 23; desires engineering or sales work with opportunity for advancement. Has year and a half experience in service department of power company. Location, immaterial. References. Available immediately. C-9034.

ELEVATOR ENGINEER, 37, married, E. E. degrees at Cornell, '20. Six and one-half years' practical experience in the engineering, manufacture and production of elevators; three additional years in application of control and signal equipment to elevators. Desires sales or sales engineering work. Location, Midwest preferred. C-4486.

1931 TECHNICAL GRADUATE of eastern college, B. S. in E. E. Experience in Bell telephone laboratories, Western Electric Company and Perryman Vacuum Tube Company. Familiar with power-line carrier telephony, vitaphone presentation, vacuum-tube production and research. Honor student at college. Desires position with a well-organized firm. C-9661.

ENGINEER, for the past 20 years in responsible positions in connection with design and construction of electric power plants, switching stations and transmission lines; also reports on electric utilities, with antecedents as blast-furnace, rolling-mill and waterworks engineer, seeks responsible work requiring preferably a combination electrical, mechanical and structural engineer. C-9332.

ESTIMATING ENGINEERING, B. S. degree in E. E., age 34, married. Ten years' experience with large company manufacturing electrical power equipment, includes designing electrical and mechanical construction and calculating cost, weight, and dimensions of this apparatus in connection with customers' negotiations. Available at once. Location, immaterial. C-4633.

ELECTRICAL ENGINEER, B. S. degree Lehigh University, single, age 22. Desires position with utility, construction, or manufacturing company. Location, immaterial. One summer with New York Edison Company, Test Bureau. Available immediately. C-9702.

ELECTRICAL ENGINEER, B. S. in E. E., University of Michigan, August 1931. Eight months student engineer with electrical manufacturer prior to graduation. Associate member of Sigma Xi. Full member of Sigma Rho Tau honorary speech society. Unusual success in collegiate debating and public speaking indicate desirability of sales work. Location, immaterial. C-9709.

GRADUATE ELECTRICAL ENGINEER, B. S. in E. E., 1931, intends to study for M. S. degree at night; 21, single. Desires position in any electrical engineering field including radio or vacuum-tube work. Available at once. Location, New York preferred but not essential. C-9467.

ELECTRICAL ENGINEER, 26, single, Swiss graduate, 1928. Full quota immigrant. Experience: assistant designer of transformer stations and substations. Insulator testing. Research in the States. Graduate student at M. I. T. Speaks fluently French, English, and German. Connection with outstanding firm; testing, research, or manufacturing desired. Location, immaterial. C-9654.

GRADUATE ELECTRICAL ENGINEER, B. S. in E. E., 1928, 26, single. Two and one-half years' experience as designing engineer on distribution and metering transformers. Desires position with public utility, contracting, or industrial concern. Available at once. Location, immaterial. C-9693.

ELECTRICAL ENGINEER, two years' Westinghouse Test; 25 years' experience, partly in South America as engineer and manager of public utilities, and mining. Speak Spanish fluently. Also Diesel-engine and refrigeration experience. Location, immaterial. B-5912.

GRADUATE ELECTRICAL ENGINEER, age 28, married, with eight years' experience in industrial plant construction and maintenance; railway electrification; power-plant design, estimating, and construction. Supervisory experience on construction and costs with contractor. Desires position with utility manufacturer or contractor, where ability to handle labor and produce results is a prerequisite. C-4428.

1931 ELECTRICAL ENGINEERING GRADUATE, age 23, B. S. at North Carolina State College. Desires position with opportunity for advancement with utility, manufacturing, or any other engineering firm. Can furnish best of references. Location preferred, East or Middle West. C-9660.

ELECTRICAL ENGINEER, B. S. in E. E. '31, 23, single. Has had some experience in telephony. Desires position with power or telephone company. Available immediately. Location, immaterial. C-9710.

1931 TECHNICAL GRADUATE, B. Sc. in E. E. from a midwestern university, desires permanent connection with chance for advancement. Age 26. Location, immaterial. Available immediately. C-9717.

SALES ENGINEER, graduate E. E. and N. Y. State licensed professional engineer, twelve years' experience, capable correspondent, thoroughly familiar with routine office details, sales-promotion programs, training and handling men, direct sales to industrials and utilities, preparing specifications, designing industrial motor drives, control wiring diagrams and substation design. C-5239.

JUNIOR ENGINEER, 1931 graduate, B. S. E. E., University of Alabama. Desires position with utility, construction, manufacturing company. Location, immaterial. Experienced in power-plant and building installation and industrial control, having been employed for eight summer months and one full year, first as electrician helper and later as first-class electrician. C-9446.

GRADUATE ENGINEER, B. S. in E. E., 25 years' experience in electrical, mechanical design operation, maintenance and construction of power plants. Last seven years on construction and putting in operation of power-plant equipment. Combustion, heating and high-pressure piping installations. Available now. C-7848.

SALES ENGINEER AND EXECUTIVE, electrical and mechanical training, seven years' sales engineering and executive experience in application of precision equipment to electrical equipment. Would like opportunity to develop sales of mechanical product allied with electrical industry or of electrical nature sold to central stations and industrials. C-5431.

1930 ELECTRICAL ENGINEER, Rensselaer Polytechnic Institute, 24, 5'8¾", 160 lb., in very good health, desires immediate connection. Will go anywhere, anytime; will take foreign service if necessary. Hydroelectric and power maintenance, construction and installation before graduation. Willing to start in as draftsman if necessary. Quite studious and ambitious. C-7936.

ELECTRICAL ENGINEER, technical graduate, 32, married. Twelve years' experience in design of steam and hydroelectric power stations, bus-stations, and industrial plants, including estimates, costs, specifications, purchase of equipment, drafting, and construction supervision. Desires position with public utility, engineering or industrial concern. References. New England preferred but will consider other location. C-9715.

ELECTRICAL ENGINEER with wied practical experience in design, construction, operation, distribution, superintendence of gas and electric public utilities, desires permanent connection with industrial organization in the Middle or Far West. C-9668.

RECENT GRADUATE, 23, Pratt Institute in industrial electrical engineering. Desires position with power company or related work in manufacturing or construction. Location, East. C-9727.

MECHANICAL AND ELECTRICAL ENGINEER, research, development, reports. Phys. tests of material. Metallography, X-ray analysis. Languages: French, and German. Available on short notice. Location, immaterial. C-6994.

ELECTRICAL ENGINEER, graduate Lehigh University 1922. Experienced all kinds construction, transmission work power plants, substations, étc. mostly as draftsman laying out such work. Also familiar with electrification in anthracite fields. Willing to accept drafting, engineering, or any other electrical position. Location, eastern states preferable but anywhere considered. C-9723.

GRADUATE ELECTRICAL ENGINEER, 22, single, B. S. in E. E. 1931, Lehigh University. Three months' summer experience testing department large public utility. Desires position with utility company. C-9721.

INTERNATIONAL OR DOMESTIC BUSINESS, university graduate, 31, thoroughly trained and experienced, seven years engineering and business U. S. and abroad; export, power system planning, developments, reports, estimating, organizing; foreign languages: German, Spanish, some French. Desires connection holding company or trade; will consider representing concern abroad. Available short notice. C-3534.

INTERNATIONAL BUSINESS, electrical engineer, 30, single; citizen, college graduate here and abroad, widely traveled, speaks Scandinavian, German, fair French, some Russian, five years' American engineering experience, power plant and substation design and construction. Desires permanent position with holding company or representating manufacturer abroad. Excellent references. Personal interview desired. Location immaterial. C-9730.

ELECTRICAL ENGINEER, 43, married; twenty years' electrical, power, and industrial plants experience in construction, maintenance of distribution and transmission lines; desires position with public utility or industrial plant. Can qualify as electrical superintendent. Used to handling men. Available short notice. Canada preferred but would consider other location. C-9459.

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ELECTRICAL - MECHANICAL ENGINEER, 24, single, graduate Cooper Union night school of engineering, 1931, degree B. S. in E. E. Eight years' industrial experience including machine shop, mechanical, electrical design work; some radio and patent work. Speak German fluently. Desires position, vicinity of New York City or suburbs. Available immediately. Excellent references. C-8357.

ELECTRICAL ENGINEER, B. S. in E. E. from well-known institution, 1931, single, 22, available immediately. Summer experience in generator design, sales, and shop work. Research experience in industrial power tubes. Excellent scholastic record. References furnished. Moral habits and good health. Location, immaterial. C-9699.

ELECTRICAL - MECHANICAL ENGINEER, 44, married, technical university graduate. Eighteen years' practical experience; design, test, operation of a-c. and d-c. motors, generators, contactors, relays, switches, controllers, electro-mechanical devices. Elevator and hoisting equipment, construction and installation. Technical management. Development and production work. Location, New York City vicinity or East. Available immediately. B-5240.

ELECTRICAL - MECHANICAL ENGINEER, married, graduate electrical engineer, New York and New Jersey professional licenses, 15 years' experience illumination, flood-lighting, wiring, service vaults, house switchboards, and underfloor duct for office buildings. Maintenance and plant engineering work in textile, zinc, steel, and small parts manufacturing plants. Specifications, purchasing and executive experience. B-5026.

ASSOCIATE ELECTRICAL ENGINEER, 37, married, twelve years with Westinghouse; apprentice course, sales and shop. One and one-half years Western Electrical Engineering department, writing inspection methods instructions. Knowledge of oscillograph testing and meters. C-8817.

MANAGER, EXECUTIVE ENGINEER, 41, superintendent, consultant, sales engineer, assistant to major executive. Electrical utility properties, management organizations, industrials, manufacturers. Broadly trained, twenty years diversified responsibilities, five connections. Demonstrated ability large projects. Sound economical design, construction, operation. Extensive changeover programs, networks, underground systems. Vitally energetic, American. Salary not immediate objective. C-3963.

ELECTRICAL ENGINEER, experienced also in metallurgy and electro chemistry, has been employed for more than six years in physical research laboratories, desires similar position. B-9034.

1931 GRADUATE ELECTRICAL ENGINEERING, B. S. in E. E. University of Delaware, single, age 21. Special courses taken in physics and radio. Desires position with any manufacturing or engineering firm. Location, immaterial, opportunity and experience being main factors. Available immediately. C-9666.

ELECTRICAL ENGINEERING ASSISTANT, 26, married, college graduate, four years' transmission and distribution experience with public utilities on design, estimates, survey, and evaluation. Desires connection with public utility engineering department. New York City preferred, but will consider any United States location. C-5511.

1930 GRADUATE OF ELECTRICAL ENGINEERING, under the cooperative plan at Georgia Tech. Worked alternate months with public utility company in Georgia in the following departments: car-barn, gas, engineering, hydro-generation, and statistics. Since graduation has worked six months with transmission line construction crew. Any location. C-9210.

Instructors

ELECTRICAL ENGINEER, 36, desires position as professor or instructor in E. E. at college, university or technical school. University graduate; two and one-half years' instructor; two years' machine design with Westinghouse; seven years' design of electric power stations; competent supervisor. Correspondence invited. C-9593.

INSTRUCTOR in design engineering. Ten years' practical experience on the design, construction, installation and calculations of overhead distribution lines and underground networks. Location preferred, Southwest. Available at once. C-4734.

ELECTRICAL ENGINEER, B. S. E. E. '29, M. S. E. E. '31, leading university, eighteen months General Electric Test, 23, single. Desires to teach in technical university. Prefers Midwest. C-9320.

GRADUATE ELECTRICAL ENGINEER, M. S. in E. E., 1931 from M. I. T. General Electric Test experience. Experience in the design of motors and generators. Available upon short notice. Location, immaterial. C-9559.

ELECTRICAL ENGINEER, B. S. E. E. degree from southern university, 1930, age 21, single. Desires position with manufacturing concern offering a future, or as instructor in electrical engineering. Location, immaterial. Available at once. C-9607.

ELECTRICAL ENGINEER, college graduate, advance studies, 29, married, Westinghouse training. Six years' experience as designer of electrical circuits and mechanical details of control apparatus. All kinds of control apparatus, specializing on elevators. Qualified for responsible position. Location, immaterial. Available on short notice. C-9638.

ELECTRICAL ENGINEER, teacher, married, university graduate. Four years instructor in state university; five years in testing and design departments of operating company; six years with consulting engineering firm in central station design; eight years with engineering and management corporation, five years as assistant electrical engineer. Available on short notice. C-9629.

METER OR TESTING ENGINEER, 29, B. S. in E. E., honors, standard university. Ten years' experience; utilities, standardization, meter, transmission, plant departments. Started reading meters. One year sales engineer, large instrument manufacturer. Good records and references. Qualified for industrial or utility construction, testing, or operation. Location immaterial. Will travel. Available immediately. C-9667.

ASSISTANT PROFESSOR OR INSTRUCTOR, Cornell graduate, diversified practical work, two and one-half years' teaching experience. Thoroughly familiar with present day practise in mechanical and electrical equipment for industrial and power work. A-3702.

ELECTRICAL ENGINEER, M. S. 1931 from M. I. T., 23, single. Summer experience with American Tel. and Tel. Company. Desires position with electrical company preferably in research laboratory or as instructor in E. E mathematics, or physics. Available immediately. Location, East or Middle West. C-9674.

POSITION AS INSTRUCTOR OR ASSISTANT PROFESSOR in technical school for E. E. wanted. Age 28, degrees of S. B. S. M. in electrical engineering. Can handle classes in any phase of work relating to power plants, substations, radio distribution, or transmission. East preferred. Employed at present. C-5744.

GRADUATE ELECTRICAL ENGINEER, class 1926, Columbia, age 28, married. Practical experience with power company and telephone company. One year as laboratory assistant in electrical classes and three years as instructor in evening classes in college mathematics have aroused a sincere desire to make teaching life work, as instructor in E. E. mathematics, or physics. C-9308.

RELAY, CONTROL ENGINEER, 30, McGill graduate. Have done responsible engineering work planning relay applications, protective circuits, automatic, supervisory controls. Thoroughly familiar, equipment large generating, substations, use of laboratory facilities, field engineering methods. Valuable experience, communication circuits, amplifiers, photoelectric cells, maintenance of highest standards in their circuits. Proved ability in personal contact. Location, Canada. C-4668.

1929 ELECTRICAL DESIGN ENGINEER, 24, B. S. degree technical school. One year Westinghouse student course. Motor, transformer, turbo test experience. One year large synchronous motor design. Six months Westinghouse electrical design school. Desires position; design, research, development work, manufacturing company, or engineering department power company. Single with dependents. Location, immaterial. References. Available immediately. C-9410.

Membership

Recommended for Transfer

The board of examiners, at its meeting of July 29, 1931, recommended the following members for transfer to the grade of membership indicated. Any objection to these transfers should be filed at once with the national secretary.

To Grade of Fellow

BURKHOLDER, CHARLES I., vice-pres., Duke Power Co., Charlotte, N. C.

CREIM, BENJAMIN W., chief elec. engr., Modesto Irrigation District, Modesto, Calif.

To Grade of Member

ALLEN, CLAYTON M., junior elec. eng., Dept. of Water and Power, Los Angeles, Calif.

BEAR, FRED T., elec. engr., Delaware Pr. & Light Co., Wilmington, Del.

BRAUN, ELMER H., junior engr., N. Y. & Queens Elec. Lt. & Pr. Co., Flushing, N. Y.

BUCK, O. KENDALL, supervising power salesman, Dept. of Water and Power, Los Angeles, Calif.

CRANE, CARL C., substation engr., Northern Indiana Public Service Co., Hammond, Indiana.

DAVIS, ARTHUR L., asst. gen'l. supt., Western Massachusetts Companies, Turners Falls, Mass.

DORMER, WILLIAM J. S., division toll-plant engr., Bell Telephone Co. of Canada, Montreal, Can.

DUNCAN, JAMES A., research engr., Brooklyn Edison Co., Inc., Brooklyn, N. Y.

EITMAN, JOSEPH F., design engr., General Electric Co., Fort Wayne, Indiana.

HARRIS, HIRAM D., instructor in E. E. and physics, Rensselaer Polytechnic Institute, Troy, N. Y.

HOLLADAY, WM. L., engg. mgr., The George Belsey Co. Ltd., Los Angeles, Calif.

KATZMAN, JACOB, elec. engr., Dubilier Clock Corp., New York.

LEE, Jr., STEWART, engg. dept., N. Y. Shipbuilding Co., Camden, N. J.

MOORE, LEONARD J., exec. engr., San Joaquin Lt. and Pr. Corp., Fresno, Calif.

MORGAN, THEODORE H., asst. prof. of E. E., Stanford University, Stanford University, Calif.

MOSER, FRED L., supt. of maintenance, Duke Power Co., Charlotte, N. C.

NAEF, OTTO, consulting engr., American Brown Boveri Co. Inc., Camden, N. J.

POLKINGHORN, FRANK ALLEN, member of tech. staff, Bell Telephone Laboratories Inc., New York.

RICHARDSON, HARVEY R., laboratory engr., Brooklyn Edison Co. Inc., Brooklyn, N. Y.

SCHULZE, RAYMOND C. R., assistant engr., Public Service Elec. & Gas Co., Newark, N. J.
SHADGETT, LAURENCE M., supt. wholesale operations, Georgia Power Co., Atlanta, Ga.
SHARP, HUBERT, transmission engr., Mountain States Tel. & Tel. Co., Denver, Colo.
SMITH, HUGH L., engr., General Electric Co., New York.
TUCKER, WILMER H., elec. engr., The Hoover Co., North Canton, Ohio.
WALSH, HOWARD A., field engr., Doble Engineering Co., Boston, Mass.
WOODS, JOHN C., designer, Commonwealth Edison Co., Chicago, Ill.

Applications for Election

Applications have been received by the secretary from the following candidates for election to membership in the Institute. Unless otherwise indicated, the applicant has applied for admission as an Associate. If the applicant has applied for direct admission to a grade higher than Associate, the grade follows immediately after the name. Any member objecting to the election of any of these candidates should so inform the Secretary before September 30, 1931.

Bantau, J. W., Paramount Publix Corp., Los Angeles, Calif.
Benson, A., Oklahoma A. & M. College, Stillwater, Okla.
Coleman, G. G., The Chesapeake & Potomac Tel. Co., Washington, D. C.
Cook, J. F., Jr., R. C. A. Victor Co., Jamaica Plain, Mass.
Cruickshank, J. P., Appalachian Electric Power Co., Huntington, W. Va.
Fricker, W. R., Canadian Westinghouse Co., Ltd., Regina, Sask., Can.
Hipp, R., Jr., Broad River Power Co., Pomaria, So. Car.
Inkster, O., Saskatchewan Power Commission, Regina, Sask., Canada
Ireland, G. (Member) American Tel & Tel. Co., New York, N. Y.
Jastram, R., Star Electric Motor Co., Newark, N. J.
Kurdy, S. M., Automobile Laundry Engineering Corp., Newark, N. J.
Levoy, L. G., Jr., General Electric Co., Schenectady, N. Y.
Lytle, C. M., Kansas City Pr. & Lt. Co., Kansas City, Mo.
Maessen, F. T., 412 City-Central Bldg., San Antonio, Tex.
Merrill, C. B., Bell Tel. Co. of Pa., Pittsburgh, Pa.
Moscato, F., Automatic Musical Inst. Co. of Grand Rapids, Mich., Central Park, L. I., New York.
Murphy, P. J., Dept. of Public Works, Essondale, B. C., Can.
Porter, F. C., United Elec. Lt. & Pr. Co., New York, N. Y.
Rees, J. B. (Member) American Tel. & Tel. Co., New York, N. Y.
Roberts, W. N., Box 15, Woodside, L. I., N. Y.
Rosenberger, G. L., Virginia Public Service Co., Alexandria, Virginia
Sanford, R. V. (Member) Tucson Gas, Elec. Lt. & Pr. Co., Tucson, Ariz.
Sharp, R. E. B., (Member), J. P. Morris & De La Vergne, Inc., Philadelphia, Pa.
Stoll, G. M., N. J. Bell Telephone Co., Asbury Park, N. J.
Thorne, E. C., Southern Canada Power Co., Drummondville, Que., Can.
Tingley, F. T. (Member) Clemson College, Clemson College, So. Carolina.
Valverde, R., Valverde Laboratory, New York, N. Y.
von Turffs, H., Montana Power Co., Bozeman, Mont.
Winkler, S. C. (Member) Los Angeles Junior College, Los Angeles, Calif.
Wright, R. B., United Electric Lt. & Pr. Co., New York, N. Y.
Wyman, A. W., Warren Telechron Co., Ashland, Mass.

31 Domestic

Foreign

Gillett, J. K. (Member) Metropolitan-Vickers Elec. Co., Trafford Park, Manchester, England
Stratten, T. P., DeBeers Cons. Mines, Ltd., Kimberley, S. Africa
Ratnam, G. M., Chola Power House, Dist. Thana, Bombay, India
Thomson, L. P., Estacion Lacroze, Buenos Aires, S. A.

4 Foreign

September 1931

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☐ 31-122	C. C. Campbell and H. N. Kalb	Radio Coordination
☐ 31-123	C. E. Magnusson	The Kindling of Electric Sparkover
☐ 31-124	H. H. Skilling	Tuned Power Lines
☐ 31-125	E. M. Calderwood and D. F. Smith	The San Francisco-Los Angeles Section of The Pacific Coast Telephone Cable Networks
☐ 31-126	G. D. Floyd and J. R. Dunbar	Calorimeter Measurement of Stray-Load Losses of 55,000-Kva. Generator Having Enclosed System of Ventilation
☐ 31-127	T. E. Purcell and C. A. Powel	Tie-Line Control of Interconnected Networks
☐ 31-128	H. C. Hill and J. B. Se Legue	Electrical Equipment for Oil-Field Operation
☐ 31-129	J. J. Pilliod	Intercontinental Radiotelephone Service from the United States
☐ 31-130	E. A. Crellin	The Mokelumne River Development
☐ 31-131	E. M. Wright and B. D. Dexter	Power Transmission and Distribution From the Mokelumne River Development of the Pacific Gas and Electric Company
☐ 31M1	C. E. Carey and K. L. Howe	Electric Power in the Wood-Products Industry
☐ 31M2	S. B. Clark	A-C. Networks in Portland, Oregon
☐ 31M3	C. F. Green	Electrical Solutions of Problems of Regular Scheduled Flight
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☐ 31M5	S. S. Mackeown	Cathode Drop in Arcs and Glow Discharges
☐ 31M6	A. L. Albert and W. R. Bullis	Electrical Measurements of Sound-Absorption
☐ 31M7	Vaino Hoover	Correlation of Induction Motor Design Factors

Papers presented prior to September 1931 upon which articles in this issue are based

Number	Author	Title
☐ 31-25	Philip Sporn and H. P. St. Clair	Oil Circuit Breaker Tests—Philo 1930, Aims, Set-up and Results From a System and Operating Viewpoint
☐ 31-26	R. M. Spurck and H. E. Strang	Circuit-Breaker Field Tests on Standard and Oil-Blast Explosion Chamber Oil Circuit Breakers
☐ 31-27	B. M. Pickens	Inclined-Catenary Calculations
☐ 31-39	R. C. Bergvall	Series Resistance Methods of Increasing Transient Stability Limits
☐ 31-51	N. F. Clement and E. E. Richards	Design of Catenary System for Cleveland Union Terminal
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Maine, Univ. of	Orono, Maine	1	Ronald E. Young	Roland J. Tibbetts	W. E. Barrows
Marquette Univ	Milwaukee, Wis	5	Ellsworth Ziehm	Donald Boehmer	Edward Kane
Massachusetts Inst. of Tech	Cambridge, Mass	1	John C. Gibson	Thomas R. Smith	W. H. Timbie
Michigan Col. of Mining and Tech	Houghton, Mich	5	A. G. Rogers	M. D. Crowell	G. W. Swenson
Michigan State College	East Lansing, Mich	5	Edwin W. Moore	Webster Bowler	W. A. Murray
Michigan, Univ. of	Ann Arbor, Mich	5	A. D. Forbes	G. Muffly	S. S. Attwood
Milwaukee, School of Eng. of	Milwaukee, Wis	5	Wm. P. Gainer	H. F. Volkmann	V. M. Murray
Minnesota, Univ. of	Minneapolis, Minn	5	M. G. Swanson	S. McDermott	J. H. Kuhlmann
Mississippi Agri. & Mech. Col	A. & M. College, Miss	4	J. M. Leigh	J. T. Young	L. L. Patterson
Missouri School of Mines & Met	Rolla, Mo	7	J. D. Shelton	G. L. Leisher	I. H. Lovett
Missouri, Univ. of	Columbia, Mo	7	R. L. Young	R. Osadchey	M. P. Weinbach
Montana State College	Bozeman, Mont	9	Homer Lambdin	Wesley C. Funk	J. A. Thaler
Nebraska, Univ. of	Lincoln, Neb	6	P. Ehrenhard	Wm. M. Ely	F. W. Norris
Nevada, Univ. of	Reno, Nevada	8	Donald Knapp	Orvis E. Reil	S. G. Palmer
Newark College of Eng	Newark, N. J	3	E. Olsta	J. G. Woehling	J. C. Peet
New Hampshire, Univ. of	Durham, N. H	1	P. A. Rolfe	R. H. Williams	L. W. Hitchcock
New Mexico, Univ. of	Albuquerque, New Mexico	7	M. Austin True	Stanley O. Fish	F. M. Denton
New York, Col. of the City of	New York, N. Y	3	A. Rosenberg	I. E. Lawlor	Harry Baum
New York Univ	Univ. Heights, New York, N. Y	3	L. E. Dinnar	G. M. Heckel	J. L. Arnold
North Carolina State College	Raleigh, N. C	4	G. E. Ritchie	L. C. Hubbard	R. S. Fouraker
North Carolina, Univ. of	Chapel Hill, N. C	4	D. J. Thurston, Jr	Sam Barham	J. E. Lear
North Dakota Agri. College	Fargo, N. D	6	Clarence Bryant	Ralph Simenson	H. S. Rush
North Dakota, Univ. of	Grand Forks, N. D	6	B. J. Shields	Mark Scarff	H. F. Rice
Northeastern Univ	Boston, 17, Mass	1	A. K. Wright	P. H. Townsend	W. L. Smith
Notre Dame, Univ. of	Notre Dame, Ind	5	Hugh Ball	F. A. Consolati	J. A. Caparo
Ohio Northern Univ	Ada, Ohio	2	O. R. Jacobs	W. Gideon	I. S. Campbell

Student Branches of the Institute—Continued

Name	Location	District	Chairman	Secretary	Counselor (Member of Faculty)
Ohio State Univ	Columbus, Ohio	2	Charles L. Lucal	G. W. Moyer	F. C. Caldwell
Ohio Univ	Athens, Ohio	2	George Wyckoff	William Cooper	A. A. Atkinson
Oklahoma Agri. & Mech. College	Stillwater, Okla	7	Joe W. Hutchins	Clyde V. Benson	A. Naeter
Oklahoma, Univ. of	Norman, Okla	7	Chas. C. Ludwick	J. Strossberger	F. G. Tappan
Oregon State College	Corvallis, Ore	9	Dale Hansen	George Howie	F. O. McMillan
Pennsylvania State College	State College, Pa	2	J. N. Seiler	J. W. Hostetter	L. A. Doggett
Pennsylvania, Univ. of	Philadelphia, Pa	2	C. N. Maxfield	H. D. Sarkis	C. D. Fawcett
Pittsburgh, Univ. of	Pittsburgh, Pa	2	W. J. Howell	R. H. Kernahan	H. E. Dyche
Pratt Inst	Brooklyn, N. Y	3	Wm. H. Sutton	Ronald L. Bishop	C. C. Carr
Princeton Univ	Princeton, N. J	2	Frank L. Thomson	Ernest E. George	Malcolm MacLaren
Purdue Univ	Lafayette, Ind	5	P. O. Peterson	E. M. Sharer	A. N. Topping
Rensselaer Poly. Inst	Troy, N. Y	1	J. J. Lewis	H. A. Schlieder	F. M. Sebast
Rhode Island State College	Kingston, R. I	1	Leon C. Breault	Lloyd E. Crandall	William Anderson
Rice Inst	Houston, Texas	7	M. E. Kattmann	E. A. Turner, Jr	J. S. Waters
Rose Poly. Inst	Terre Haute, Ind	5	Robert Roach	Charles E. White	C. C. Knipmeyer
Rutgers Univ	New Brunswick, N. J	3	Fred T. Kent, Jr	W. M. Reiley	F. H. Pumphrey
Santa Clara, Univ. of	Santa Clara, Calif	8	L. W. Thorpe	T. Eberhard	E. F. Peterson
South Carolina, Univ. of	Columbia, S. C	4	L. E. Rankin	L. W. Dickinson, Jr	T. F. Ball
South Dakota State Sch. of Mines	Rapid City, S. D	6	Almon M. Bjerke		J. O. Kammerman
South Dakota, Univ. of	Vermillion, S. D	6	Myron Cole	Carl Bauman	B. B. Brackett
Southern California, Univ. of	Los Angeles, Calif	8	M. C. Marshall	Louis Bayha	W. G. Angermann
Southern Methodist Univ	Dallas, Texas	7	J. V. Melton	Porter Lindsley, Jr	H. F. Huffman
Stanford Univ	Stanford University, Calif	8	M. R. Jones, Jr	Ronald H. Born	
Stevens Inst. of Tech	Hoboken, N. J	3	G. J. Costello	F. F. Fuller	F. C. Stockwell
Swarthmore College	Swarthmore, Pa	2	Lewis Fussell, Jr	Robert H. Lamey	Lewis Fussell
Syracuse Univ	Syracuse, N. Y	1	Donald Robinson	W. Kleppinger	C. W. Henderson
Tennessee, Univ. of	Knoxville, Tenn	4	H. M. Patterson	C. T. Nunley	J. G. Tarboux
Texas Agri. & Mech. College	College Station, Texas	7	T. M. Sowell	E. A. Stobart	H. C. Dillingham
Texas Tech. College	Lubbock, Texas	7	Walter Burns	Everitt Dison	W. J. Miller
Texas, Univ. of	Austin, Texas	7	T. E. Cole	D. Sussin	J. A. Correll
Utah, Univ. of	Salt Lake City, Utah	9	R. C. Hansen	Wm. S. Nishiyama	A. LeRoy Taylor
Vermont, Univ. of	Burlington, Vt	1	Donald E. Child	Robert A. Hyde	L. P. Dickinson
Virginia Military Inst	Lexington, Va	4	J. C. Shell	E. R. Trapnell	S. W. Anderson
Virginia Poly. Inst	Blacksburg, Va	4	R. E. McDaniel		Claudius Lee
Virginia, Univ. of	University, Va	4	G. G. Quarles	T. J. Peterson	W. S. Rodman
Washington, State Col. of	Pullman, Wash	9	D. H. Olney	G. C. O'Brien	Orren E. Osburn
Washington Univ	St. Louis, Mo	7	Don A. Fischer	E. A. Wolff	W. L. Upson
Washington, Univ. of	Seattle, Wash	9	Allen S. Koch	F. Buckman	G. L. Hoard
West Virginia Univ	Morgantown, W. Va	2	P. J. Johnson	C. F. Stewart	A. H. Forman
Wisconsin, Univ. of	Madison, Wis	5	A. G. Woodford	T. N. Racheff	C. M. Jansky
Worcester Poly. Inst	Worcester, Mass	1	R. G. Driscoll	Wm. A. Ardito	C. D. Knight
Wyoming, Univ. of	Laramie, Wyo	6	Neil Sanders	Roy Perkins	G. H. Sechrist
Yale Univ	New Haven, Conn	1	Ludwig B. Hansen	F. M. Wolff	W. B. Hall
Total 109					

Affiliated Student Society

Brown Engineering Society..........Brown Univ., Providence, R. I.

Engineering Literature

New Books

In the Societies Library

AMONG the new books received at the Engineering Societies Library, New York, during July are the following which have been selected because of their possible interest to the electrical engineer. Unless otherwise specified, books listed have been presented gratis by the publishers. The Institute assumes no responsibility for statements made in the following outlines, information for which is taken from the preface or text of the book in question.

Business Adrift. By W. B. Donham. N. Y., McGraw-Hill Book Co., 1931. 165 pp., 9 x 6 in., cloth, $2.50.——A thoughtful, important contribution upon the problems that threaten our future economic well-being. The author discusses the part that business men must play in meeting the needs of the American people, and offers a plan for the future which will meet changing business conditions intelligently.

Aircraft Yearbook, 1931. Edit. by Aeronautical Chamber of Commerce. N. Y., D. Van Nostrand Co., 1931 607 pp., illus., diagrs., charts, maps, tables, 9 x 6 in., cloth, $6.00.——Reviews technical and commercial developments during the year. Describes the air lines in operation and the work of the army and navy, the activities of colleges, the changes in airplane design, legislation, etc. Drawings of all aircraft and engines in production are given, together with much statistical information.

Abfluss-Untersuchungen und-Berechnungen für Ueberfälle an Scharfkantigen Wehren. (Mitteilungen aus dem Gebiete des Wasserbaues und der Baugrundforschung, Heft 4.) By C. Keutner. Berlin, W. Ernst & Sohn, 1931. 27 pp., illus., diagrs., 11 x 7 in., paper, 4.20-r. m.——Gives the results of observations of flow phenomena over weirs in glass channels and of experiments to find equations for the flow which will be accurate in cases where the usual equations fail. Rehbock's formula is found correct for certain conditions; other formulas are developed for special cases.

Elements of Thermodynamics. By Ernest M. Fernald. N. Y., McGraw-

Hill Book Co., 1931. 329 pp., charts, diagrs., tables, 9 x 6 in., cloth. $3.50.——Professor Fernald's aim is to give the student an adequate, flexible technique for dealing quantitatively with various situations, and sufficient data for meeting the simpler ones; together with clear ideas of the limitations that universal laws impose upon engineering practise, and of the conditions that practise must meet before finally perfected. The properties, processes, and cycles of steam and perfect gases, compressed air, refrigeration, evaporation and flow through nozzles, etc., are discussed.

Practical Radio including Television. 4th edit. By J. A. Moyer and J. F. Wostrel. N. Y., McGraw-Hill Book Co., 1931. 410 pp., illus., diagrs., charts tables, 8 x 5 in., cloth, $2.50.——A popular exposition of the principles of radio and of the usual types of receiving apparatus. Advice on the selection and operation of receivers is given and also upon the construction and testing of some typical sets. This edition has a new chapter on television as well as numerous revisions and corrections.

Practical Marine Diesel Engineering. 2nd edit. By L. R. Ford. N. Y., Simmons Boardman Publ. Co., 1931. 758 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth. $7.00.——Discusses construction and operation from the point of view of the practical engineer. Theoretical principles are explained briefly, the construction of the various parts of engines and the accessory equipment described, and detail given for a large number of makes of engines. A major portion of the book is devoted to operation, such matters as repairs, tests, and lubrication being explained quite fully.

Berechnungsgrundlagen und Konstruktive Ausbildung von Einlaufspirale und Turbinensaugrohr bei Niederdruckanlagen. By H. Rohde. Berlin, J. Springer, 1931. 112 pp., illus., diagrs., charts, tables, 10 x 6 in., paper, 11 r. m.——The design and construction of these important elements of a power plant are both hydraulic and mechanical problems, and the present book is intended to throw light upon the structural and mechanical phases of the subject. The study is intended to assist in determining the most efficient forms, with due attention to both hydraulic and structural considerations.

Aerial and Marine Navigation Tables. By J. E. Gingrich. N. Y., McGraw-Hill Book Co., 1931. 63 pp., diagrs., tables, 11 x 7 in., leather, $2.50.——The aim of the compiler of these tables has been to combine speed, facility in use, and simplicity with accuracy. A uniform plan in the solution of all sights has been adopted, and the volume is usable over a wide range and of handy size. The tables are a rearrangement of those devised by Doctor Ogura of the Japanese Navy.

Electrical Engineering. By C. V. Christie. N. Y., McGraw-Hill Book Co., Inc., 1931. 662 pp., diagrs., charts, tables, 9 x 6 in., cloth, $5.00.——The fourth edition of this well-known text preserves the characteristics of former issues, but certain additions have been made, including an outline of the mathematical relations required for solving problems in a-c. theory, the design of a commutating-pole d-c. generator, a discussion of the problem of system stability, and a set of typical problems.

L'Emploi des Unités dans la Pratique des Calculs. By F. Bétrancourt. Paris, Dunod, 1931. 91 pp., tables, 9 x 6 in., paper, 16 frs.——A collection of the geometrical, mechanical, electrical, magnetic, and optical units of measurement, with definitions, formulas, etc., intended to aid calculators.

Experimental Radio Engineering. By J. H. Morecroft. N. Y., John Wiley & Sons, 1931. 345 pp., illus., diagrs., charts, tables, 10 x 6 in., cloth, $3.50.——A laboratory course in the principles of radio, listing fifty-one experiments and designed to bring out characteristics of component parts of receiving and transmitting apparatus; the introduction is upon laboratory apparatus.

Sags and Tensions in Overhead Lines. By C. G. Watson. London & N. Y., Isaac Pitman & Sons, 1931. 192 pp., diagrs., charts, tables, 9 x 6 in., cloth, $3.75.——Presenting simple accurate methods for determining these sags and tensions, and requiring no further mathematical knowledge than an ability to plot and read graphs, and perform simple arithmetical operations. All the cases ordinarily met in practise are discussed and explained. Tables and graphs of hyperbolic and catenarian functions and a table of tangents are given.

Vector Analysis. By L. R. Shorter. London & N. Y., Macmillan & Co., 1931. 356 pp., diagrs., 8 x 5 in., cloth, $2.75.——The extensive use of vector methods in modern text-books of physics makes it necessary for the student of mathematical physics to have a working knowledge of vector analysis. This brief text is intended to supply that need. It is suited also for use as an introduction to the subject for students of mathematics.

Seeing, A Partnership of Lighting and Vision. By M. Luckiesh and F. K. Moss. Baltimore, Williams & Wilkins Co., 1931. 241 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $5.——Seeing depends upon light and lighting as well as upon the visual sense; yet light and lighting have not yet received much consideration as a partner of the visual sense, the authors assert, although excellent scientific data pertaining to vision are available. The present book aims to remedy this lack, in part, by giving the results of extensive research work, covering some 20 years of effort to establish the scientific principles of seeing. A bibliography is included.

Foundations of Radio. By Rudolph L. Duncan. N. Y., John Wiley & Sons, Inc., 1931. 246 pp., illus., diagrs., tables, 8 x 6 in., cloth, $2.50.——An introductory text-book on electricity covering in non-mathematical language the fundamentals of interest to students of radio engineering.

Mitteilungen aus den Forschungsanstalten, GHH-Konzern, Bd. 1, Heft 5, pp. 101-122, May 1931. Berlin, V. D. I. Verlag. Illus., diagrs., charts, tables, 12 x 9 in., paper, 3 r. m.——The first article in this bulletin discusses the use of large diesel engines in electric power plants. Their advantages for peak-load service and as standbys are shown. The bulletin also reports on investigations of methods of drying wood and their effects upon its mechanical properties.

Nature of a Gas. By L. B. Loeb. N. Y., John Wiley & Sons, 1931. 153 pp., diagrs., charts, tables, 9 x 6 in., cloth, $2.50.——Students and engineers interested in the behavior of dielectrics as insulation will be grateful for this review of the nature and electric properties of a gas afforded by this monograph. The structure of the molecule is discussed, and its behavior under various temperature conditions considered. The monograph is the first of a series sponsored by the committee on electrical insulation of the Division of Engineering and Industrial Research, National Research Council.

Die Anwendung der Nomographie in der Mathematik. By H. Schwerdt. Berlin, J. Springer, 1931. 116 pp., charts, diagrs., tables, 10 x 6 in., cloth. 28 r. m.——This book contains 104 charts containing 236 nomographs of various mathematical formulas, which illustrate the possibilities of nomographic methods in mathematics. The text explains the charts and shows how they may be used. A brief bibliography is included.

International Critical Tables of Numerical Data, Physics, Chemistry and Technology. v. 7. By the National Research Council. N. Y. McGraw-Hill Book Co., 1930. 507 pp., 11 x 9 in., cloth $84.00 (7 v).——This is the final volume of the work in which the best values for an immense number of constants and numerical data of physics, chemistry, and engineering are recorded for the convenience of research workers. The values are based upon all recorded work previous to 1924, as in the "Annual Tables of Constants and Numerical Data." The values given in the present work have been chosen by competent authorities as the most satisfactory. References to original publications are included. Indispensable in research laboratories and libraries of science.

Onward Industry! By J. D. Mooney and A. C. Reiley. N. Y. & London, Harper & Brothers, 1931. 564 pp., 10 x 6 in., cloth, $6.00.——An endeavor to discover and define the principles of efficient organization, by studying principles used by great political, military, and ecclesiastical organizations of the past. A historical review of human experience with large organizations, accompanied by a study of present coordination and operation problems in modern industrial corporations.

Selected Items From Engineering Index Service

SELECTED references to current electrical engineering articles from Engineering Index Service's review of some 2,000 technical periodicals are given in the following columns.

All articles indexed are on file in the Engineering Societies Library, New York, which will furnish photoprints of any article at a cost of 25 cents per page or make translations of foreign articles at cost.

Busbars

PROTECTION. Differential-Bus Protection Proves Its Merit, H. H. Cox. *Elec. World*, vol. 98, no. 1, July 4, 1931, p. 30, 2 figs. Inasmuch as station bus failures are always of serious nature it was realized by engineers of Department of Water and Power of city of Los Angeles that some form of bus protection was essential; original scheme of differential bus protection was proposed by author which involved connecting in parallel of as many current transformer secondaries as there were connections to bus in question.

Cables

INSULATION. Cable Insulation Thickness Can be Reduced, D. W. Roper. *Elec. World*, vol. 98, no. 1, July 4, 1931, pp. 27-29, 6 figs. Number of questions arose in connection with development of transmission system in Chicago region, such as maximum economical size for 132-kv. cable, feasibility of 220-kv. cable and economics of use of oil-filled cable for 60 kv. or lower voltages; some preliminary studies had indicated that most economical cable for given set of conditions would be determined by annual charges rather than by first cost, and this led to decision to extend investigations in progress so as to cover entire range of transmission voltages. Before Am. Inst. Elec. Engrs.

OIL-FILLED. The Theory of Oil-Filled Cable—I, G. B. Shanklin and F. H. Buller. *Gen. Elec. Rev.*, vol. 34, no. 7, July 1931, pp. 416-420, 8 figs. Purpose of article is to round out general theory of high-tension oil-filled cable and describe additional development of important nature that have not yet been dealt with in technical press; article is sequent to recent A. I. E. E. paper by same authors "Characteristics of Oil-Filled Cable," two publications give fairly complete summary of latest oil-filled cable practise developed by General Electric Co.

Circuit Breakers

Influence de la forme de la tension de rupture sur le travail des disjoncteurs (Influence of Breaking Voltage Wave Form on Performance of Circuit Breakers), J. Kopeliowitch. *Association Suisse des Electriciens—Bul.*, vol. 22, no. 13, June 26, 1931, pp. 312-317, 8 figs. Comparative study of values obtained in cathode ray oscillographic research in 132-kv. lines of Ohio networks and in tests at high tension laboratory of Brown Boveri, Baden. Bibliography.

Clocks

ELECTRIC. Electric Clocks, F. Hope-Jones. Lond., N. A. G. Press, 1931, 261 pp., diagrs., 12 s. 6d. Combination historical and technical account of evolution of electric clock; starting with Alexander Bain's patent of 1840, author describes and criticizes efforts of successive inventors and illustrates steps that have led to highly accurate devices of today; numerous diagrams add to usefulness of book. Eng. Soc. Lib., N. Y.

Condensers

SYNCHRONOUS. Automatic Synchronous Condensers of the Washington Water Power Company, E. Baughn. *Gen. Elec. Rev.*, vol. 34, no. 7, July 1931, pp. 421-424, 4 figs. Operate on 110-kv. lines; two machines, 7,500 kva. and 10,000 kva.; purpose to increase capacity and improve voltage regulation of lines; automatic control equipment; its functions and operation under normal and abnormal conditions.

Dielectrics

Dielectric Properties and Chemical Constitution, S. O. Morgan. *Bell Laboratories Rec.*, vol. 9, no. 11, July 1931, pp. 535-542, 9 figs. Atomic study.

Diesel-Electric

POWER PLANTS, AUTOMATIC. The Present Position of the Automatic Diesel-Electric Plant, E. J. Kates. *Mech. Eng.*, vol. 53, no. 7, July 1931, pp. 525-528, 2 figs.; see also *Power*, vol. 73, no. 25, June 23, 1931, pp. 990-993, 4 figs. Paper before Am. Soc. Mech. Engrs., previously indexed from Advance Paper, for mtg. June 23-26, 1931.

POWER PLANTS—COSTS. Report on Oil Engine Power Cost for 1930. *Am. Soc. Mech. Engrs.,—Advance Paper*, for mtg. June 23-26, 1931, 5 pp. Information covering 81 oil-engine generating plants, containing 253 engines, totaling 146,865 rated b.hp.

Electrical Engineering

The High Tension Conference. *Engineering*, vol. 131, no. 3413, June 12, 1931, p. 773, 2 figs. Sixth session of International Conference on Large High Tension Systems will take place from June 18 to 27, in Paris; reports on following subjects will be presented: study of behavior of transformer and other insulating oils; design and tests of oil circuit-breakers; parallel operation of power plants; investigation of surges; study of reactive power; grounding of neutrals; high-tension insulators and high-tension underground cables.

BIBLIOGRAPHY. A Bibliography of Bibliographies in Electrical Engineering 1918-1929, edited by K. Maynard, Providence, R. I., Special Libraries Assn., 1931, 156 pp., $1.50. List of references, without annotations, from 68 serials, arranged alphabetically by subject headings, giving number of items.

Electric Discharge

AIR. Berechnung der Anfangspannung zwischen kantigen Elektroden in Luft (Calculation of Initial Voltage Between Edged Electrodes in Air), W. Schilling. *Arbeiten aus dem Institut fuer elektrische Messkunde und Hochspannungstechnik der Technischen Hochschulp Braunschweig*, vol. 1, 1931, pp. 1-12, 15 figs. Field distribution; general discharge conditions and their application in calculation for various positions and edge angles.

MERCURY VAPOR. Electrical Discharges in Mercury Vapour and Their Control, H. de B. Knight. *Rugby Eng. Soc.—Proc.*, vol. 25, pt. 1, 1930-1931, pp. 23-62, 7 figs. General features which are of importance in connection with prevention of backfiring in mercury-arc power rectifiers, and operation of thyratron. Bibliography.

Electric Drive

BLOOMING MILLS. Algoma Steel Corporation Modernizes Rail Mill, A. F. Kenyon. *Blast Furnace and Steel Plant*, vol. 19, no. 6, June 1931, pp. 832-835, 4 figs. Previously indexed from Elec. News, Apr. 1, 1931.

ROLLING MILLS. The Twin-Motor Drive for Main Rolls, R. H. Wright and H. E. Stokes. *Rolling Mill Jl.*, vol. 5, no. 6, June 1931, pp. 403-406, 4 figs. Development and advantages of this type of drive. Before Assn. Iron and Steel Elec. Engrs.

Electric Light

General and Supplementary Lighting Components, M. Luckiesh. *Elec. World*, vol. 98, no. 2, July 11, 1931, p. 74. Notwithstanding many factors involved in lighting for seeing, means available to lighting specialist for improving seeing are relatively few compared with those available to seeing specialist; among these, quantity of light, or foot-candles, is by far most effective for universal application.

ULTRA-VIOLET. Diffusely Transmitting Media for Ultraviolet Radiation, M. Luckiesh. *Elec. World*, vol. 97, no. 26, June 27, 1931, pp. 1232-1233. Results of measurements of diffuse transmission for light and for ultra-violet radiation; measurements of ultra-violet transmission were made by use of blue fluorescing attachment for Macbeth illuminometer, using sunlight "Mazda" lamp (S-1) as source of ultra-violet radiation.

Electric Manufacturing Plants

TIME-STUDY. Use of Formulas and Charts for Rate-Setting, G. J. Stegemerten. *Factory and Indus. Mgmt.*, vol. 82, no. 1, July 1931, pp. 52-56, 4 figs. Compilation of set of time tables by Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.

Electric Power

Electrical Home Service, E. E. Hoadley. *Elec. Rev.*, vol. 108, no. 2795, June 19, 1931, p. 1028. Practical comment and experience of consumers point of view on cost of service; flat irons; heating; cooking; water heating; future; all-electric homes. Before Inc. Mun. Elec. Assn.

Electrochemistry

A Method for Determining the Change in Transference Number of a Salt with Change in Concentration; a Modification of the Moving Boundary Method, E. R. Smith. *U. S. Bur. Standards—Jl. Research*, vol. 6, no. 6, June 1931, pp. 917-926, 5 figs. Junctions between solutions of same salt at different concentrations are formed and volumes through which junctions move during passage of known amounts of electricity are measured; method was tested for solutions of lithium, sodium, and potassium chloride.

Electrolytic Oxygen

MANUFACTURE. Markets for Gases Electrolyzed with Off-Peak Power, P. McMichael. *Elec. World*, vol. 97, no. 25, June 20, 1931, pp. 1182-1185, 3 figs. Outlets for oxygen well established; new hydrogen markets make electrolysis of water economically feasible; cell plant in conjunction with generating station to utilize off-peak power.

Engineering

INDUSTRIAL RELATIONSHIP. Co-ordinating Engineering with other Company Activities, L. E. Jermy. *Machine Design*, vol. 3, no. 6, June 1931, pp. 27-29. Procedure followed by eight companies using committees and conferences to broaden scope of activities of engineering departments.

INFLUENCE ON CIVILIZATION. Technology and Material Progress, W. R. Whitney. *Gen. Elec. Rev.*, vol. 34, no. 7, July 1931, pp. 403-405. Paper before Am. Philosophical Soc., previously indexed from Science, May 8, 1931.

Engineering Education

Education for the Engineering Industry. *Nature (Lond.)*, vol. 127, no. 3215, June 13, 1931, pp. 881-886. Review of report of Committee appointed by President of Board of Education to inquire into technical education for engineering industry.

Engineering Ethics

A New Code of Ethics Needed. *Eng. News-Rec.*, vol. 106, no. 26, June 25, 1931, pp. 1036-1037. Editorial on necessity of revising engineering code of ethics, in such way that advertising and competition be recognized and proper limits set upon them; fees and compensation may also need to come up for consideration.

Furnaces

ANNEALING. The Annealing of Metal Strip in the Continuously-operated Electric Furnace. *Metal Industry (Lond.)*, vol. 38, no. 26, June 26, 1931, pp. 641-643, 4 figs. In addition to electrically heated muffle furnaces, specially designed types of furnace have been put on market, and in particular, so-called "pull-through" furnaces; as against short type, horizontal pull-through furnaces, where wages constitute higher portion of total operating costs, continuously working strip annealing plants with pickling trough, washing machine and drying furnace, are capable of meeting most exacting demands.

ENAMELING. Economic Operation of Electric Enameling Furnace, A. M. Young. *Elec. World*, vol. 97, no. 25, June 20, 1931, pp. 1168-1170, 1 fig. Difference of nearly 13 per cent in net rate for furnace energy from one month to next was disclosed by recent study of electric enameling operation in plant of Chicago Hardware Foundry Co. at North Chicago, Ill.; difference was caused by varying incidences of furnace demand on total plant demand; charts showing effects of furnace load on customer's demand.

INDUCTION. Tonnage Melting by Coreless Induction—IV, E. F. Northrup. *Fuels and*

Furnaces, vol. 9, no. 7, July 1931, pp. 833-838, 3 figs. Stirring of metal and its control and power density of large and small furnaces.

REFRACTORY MATERIALS. Refractory Materials for Electric Furnaces—III, A. B. Searle. *Metal Industry* (*Lond.*), vol. 38, no. 23, June 5, 1931, pp. 569-571. Nickel and its alloys, including nickel-chromium alloys and nickel-silver; fact that nickel has melting point of 1,452 deg. cent. makes it necessary to employ, as materials for lining furnaces, those of greater refractoriness than ones used for copper and lead and their alloys.

Refractory Materials for the Induction Furnace, J. H. Chesters and W. J. Rees. *Iron and Steel Industry*, vol. 4, no. 10, July 1931, pp. 347-348. Paper before Iron and Steel Inst., previously indexed from Engineering June 12 and 26, 1931.

STEEL MAKING. Use of Sillimanite as Material for Furnace Covers, M. F. Sommer. *Blast Furnace and Steel Plant*, vol. 19, no. 6, June 1931, pp. 861-864, 1 fig. Tests indicate that sillimanite is much more expensive than silica, and durability under most favorable conditions is about same; no evidence was forthcoming which would lead to belief that through improvements in process of manufacture of either sillimanite bricks or of cover rammed up with sillimanite clay, increase in durability might be attained which would even approximately correspond to price ratio.

Generators

PARALLEL OPERATION. Re-exciting Loaded Alternators in Parallel with Others, D. D. Higgins and E. Wild. *Power*, vol. 73, no. 26, June 30, 1931, pp. 1041-1042. In order to establish reasonably safe operating procedure for such emergencies and one that will reestablish normal conditions just as soon as possible, authors have collected data on experiences and statements for various sources and have determined, by tests, behavior of large units under these abnormal conditions. Before Am. Inst. Elec. Engrs.

REGULATION. Generator Voltage Regulated by Corona Tube, H. W. Dodge and C. H. Willis. *Elec. World*, vol. 98, no. 1, July 4, 1931, pp. 25-26, 4 figs. Characteristics of corona discharge tube make its critical voltage suitable for constant element in regulator; fact that it regulates to constant peak voltage rather than constant effective voltage is not serious disadvantage, for variation of wave form with load is not appreciable and there will therefore be constant form factor. Before Am. Inst. Elec. Engrs.

SYNCHRONIZING. Correct Generator Synchronizing Insured by Auxiliary Control, J. Auchincloss. *Elec. World*, vol. 97, no. 26, June 27, 1931, p. 1214, 1 fig. Auxiliary switches on generator breaker control prevent faulty closing; wiring diagram.

Limitations in Synchronizing, H. S. Baker. *Hydro-Elec. Power Commission of Ont.—Bul.*, vol. 18, no. 6, June 1931, pp. 208-220, 23 figs. In hand synchronizing, limitations of speed difference and phase differences at moment of closure are learned in very crude manner; with automatic synchronizing it is possible to set above speed difference and phase difference limitations to known values; object of paper is to determine in rational manner values of these limitations in order to be able to make necessary adjustments to automatic synchronizing devices.

Hoover Dam

CONSTRUCTION POWER LINE. Rushing the Power Line to Hoover Dam Site, R. H. Halpenny. *Eng. News-Rec.*, vol. 106, no. 26, June 25, 1931, pp. 1054-1057, 5 figs. Rugged desert country crossed in 225 days by 225 mi. 132 kv. transmission line from San Bernardino, Cal. to serve Hoover Dam construction activities digging 7 ft. holes for tower bases; four erectors and two helpers fabricated each 52-ft. tower piece by piece from ground up; stringing three conductors at same time.

Hydroelectric Plants

DROUGHT EFFECT. Drought of 1930 Shifts Power Load to Steam Stations, G. T. Bogard. *Southern Power Jl.*, vol. 49, no. 6, June 1931, pp. 34-38, 4 figs. Following three articles outline power generation difficulties experienced in south during 1930: Unparalleled Water Deficiency Seriously Affected Even Steam Stations, G. T. Bogard; High Steam Electric Capacity Solves Drouth Problems in West Virginia, G. Ellis; Excellent Maintenance Stood Virginia System in Good Stead, M. Cary; principal generating stations as of January 1, 1931, Kentucky Utilities Company and Appalachian Electric Power Company; records of river flow and hydro power output for 1928, 1929 and 1930.

MAINTENANCE AND REPAIR. Organizing for Plant Operation and Maintenance, A. S. Robertson. *Hydro-Elec. Power Commission of Ontario—Bul.*, vol. 18, no. 6, June 1931, pp. 190-200, 5 figs. Value of service shop; organization chart and proposed maintenance schedule and actual record in days for Queenston generating station; duties of operating staff; preparing maintenance schedules; reducing time and costs; example of detailed job for rewinding a large generator; assembly of several individual job schedule sheets covering major repair on large unit.

NEW BRUNSWICK. The Economics of Power Plant Design, H. G. Acres. *Contract Rec.*, vol. 45, no. 24, June 17, 1931, pp. 731-734, 8 figs. Brief description of plant, for Edmundston, N. B., with 1,050-hp., high-speed, propeller-type, vertical turbine, direct-connected to 1,000-kva., 3-phase, 60-cycle, 2,300-volt, 240-r. p. m. generator, with direct-connected exciter and Kingsburgh thrust-bearing.

PUMPED STORAGE. High-Head Pumped-Storage Hydro-Electric Plant. *Engineering*, vol. 132, no. 3417, July 10, 1931, p. 61, 1 fig. New Plant at Sillre, town on River Indal, 220 mi. north of Stockholm; scheme is to employ power from existing plants, which is now suffered to escape in slack periods, to generate current which is to be transmitted to plant at Sillre, there to pump water up into storage reservoir.

Insulators

MANUFACTURE. The Manufacture of Porcelain Insulators. *Engineer*, vol. 151, no. 3935, June 12, 1931, pp. 658-659, 5 figs. Plants of Bullers, Ltd., at Milton and Tipton, England; manufacturing process and equipment; research work carried out by Company; every type of insulator used in electrical industry for telegraph and telephone work and for power work is made in Company's factories, including cap and pin-type insulator strings used for 132-kv. grid lines.

Lighting

COLOR. Work-World Environments, M. Luckiesh. *Mech. Eng.*, vol. 53, no. 7, July 1931, pp. 514-518. Light and color fundamentally desirable and powerful influences upon happiness; color schemes for factory interiors and machinery; economic value of pleasant environments for workers.

INDUSTRIAL. Good Lighting is a Good Investment, H. Chase. *Iron Age*, vol. 128, no. 2, July 9, 1931, pp. 84-87, 3 figs. Uniform illumination without glare or deep shadows is unquestioned aid in economical production work; examples show how properly designed system may result in enough saving to pay for equipment in less than year.

MOTOR BUS. Lighting Motor Buses and Coaches. *Ry. Gaz.*, vol. 55, no. 1, July 3, 1931, pp. 19-20, 4 figs. Details of dynamo designed to give 12 volts, 25 amp. from 1,500 to 4,000 r. p. m.; drivers switchboard; lighting controls for switchboard and interior lighting.

SHIP. Pivoted Ship Sidelight. *Engineering*, vol. 132, no. 3416, July 3, 1931, p. 28, 3 figs. New light introduced by J. Stone and Co., Deptford; sidelight is called stirrup light, as control is entirely effected by single stirrup-shaped handle.

STREET. Street Lighting and Traffic Accidents, K. M. Reid. *Elec. World*, vol. 97, no. 25, June 20, 1931, pp. 1186-1188, 3 figs. Analysis of Police department records of Cleveland, showed that traffic accidents in winter dusk exceeded midsummer's frequency; what good lighting system has accomplished; relation of lighting to fatal traffic accidents; fatalities on State roads in relation to lighting; Indiana highway fatalities. Before Am. Soc. Mun. Engrs.

UNITS. The Waidner-Burgess Standard of Light, H. T. Wensel, W. F. Roeser, L. E. Barbrow and F. R. Caldwell. *U. S. Bur. Standards—Jl. Research*, vol. 6, no. 6, June 1931, pp. 1103-1117, 4 figs. partly on supp. plate. Source of light sufficiently reproducible to serve as fundamental photometric reference standard has been obtained by carrying out in original suggestion of Waidner and Burgess to immerse hollow inclosure in bath of molten platinum and to make observation during period of freezing.

Lamps

Characteristics of Electric Lamps as Modified by Modern Methods of Manufacture, L. E. Buckell. *Machy. Market*, no. 1599, June 26, 1931, pp. 23-24. Early developments; introduction of metal filaments; gas-filled lamps; standardization; manufacturing methods; effects of small variations; uniformity of life; spiral filaments. Before Assn. Supervising Elec. Engrs.

Measuring Instruments

New Developments in Electrical Measuring and Auxiliary Testing Devices. *Nat. Elec. Light Assn.—Pub.*, no. 128, June 1931, 43 pp., 148 figs. Information concerning such devices and improvements which have been made available during year.

Meters

Direct Current Meters, S. B. Warder. *Elecn.*, vol. 106, no. 2769, June 26, 1931, pp. 941-942, 4 figs. Characteristics of ampere-hour and watt-hour meters.

SPECIFICATIONS. Summary of Public Utility Commission Rules and Regulations for Electricity Meters. *Nat. Elec. Light Assn.—Pub.*, no. 132, May 1931, 20 pp.

WATT-HOUR. Watt-Hour Meters, E. Fawssett. *Elec. Rev.*, vol. 108, no. 2795, June 19, 1931, pp. 1043-1044. Latest induction watt-hour meters are compared with those of few years ago, while there is no outstanding change to record, there has been distinct progress in detail and in performance.

Les compteurs Electriques a mercure (Mercury Watt Hour Meters), V. Neveux. *Industrie Electrique*, vol. 40, no. 935, June 10, 1931, pp. 253-261, 13 figs. Meters using mercury as low-friction material for pivoting; type of Ferranti Co., Chamberlain, Hookham, Compagnie pour la fabrication des compteurs, and Sangamo Electric Co.; applications.

Summation Meters and Some New Applications—1, C. W. Olliver. *Power Engr.*, vol. 26, no. 304, July 1931, pp. 270-273, 5 figs. Review of some modern summation equipment, with particular reference to their application to power station and other mechanical requirements.

Motor-Generators

Sur la régulation directe et les difficultés qu'entraine son etude (Direct Regulation and Difficulties in Its Analysis), Barbillion. *Revue de L'Industrie Mineralé*, no. 250, May 15, 1931, pp. 171-185, 13 figs. In more general previous study (see Engineering Index 1930, p. 624), it was assumed that proportionality existed between terminal voltage and variations in angular speed; in present article, application in cases of temporary disturbances is mathematically analyzed and some new approximately exact methods of calculation are given.

Motor Trucks

ELECTRIC. Electric Trucks. *Nat. Elec. Light Assn.—Report*, no. 138, June 1931, 12 pp., 10 figs. Degree of electric truck use by electric utilities; application to transportation work; successful truck designs and battery combinations; data and opinions gathered from operating companies.

Motors

BRAKING. Brakes for Motors and Their Loads, H. M. French. *Power*, vol. 73, no. 26, June 30, 1931, pp. 1024-1026, 5 figs. Large amount of data available on starting motors and running them to suit particular application; lack of braking information; means of retarding, stopping and holding motors under various conditions of operation.

INDUCTION—DESIGN. Theorie van den dubbel gekoppelden lek, in het bijzonder bij draaistroom-kortsluitankermotoren (Theory of Double Coupled Leak with Special Reference to Three-Phase Squirrel Cage Induction Motors), M. Van Der Veen. *Polytechnisch Weekblad*, vol. 25, nos. 20 and 21, May 14, 1931, pp. 313-316, and May 21, pp. 329-334, 15 figs. Theoretical mathematical analysis. Bibliography.

LAMINATIONS. Production of Motor Laminations, R. L. Payne. *Metal Stampings*, vol. 4, no. 6, June 1931, pp. 481-486, 9 figs. Four different methods of preparing silicon steel in sheet form for production of motor laminations and equipment used for their production; scrap economy in ultimate production of laminations lies in method of preparing sheets.

Paper Mills

POWER FACTOR. Correcting Power Factor While Grinding Wood Pulp, W. P. Lyman. *Elec. World*, vol. 97, no. 25, June 20, 1931, p. 1189, 1 fig. By applying synchronous machines to motorization of dual-drive pulper equipment, Bogalusa Paper Co. of Bogalusa, La., was able to take advantage of power-factor clauses in purchased energy contracts and secure satisfactory operating performance.

Permalloy

Researches on the Rotation of Permalloy and Soft Iron by Magnetization and the Nature of the the Elementary Magnet, S. J. Barnett. *Am. Academy Arts and Sciences—Proc.*, vol. 66, no. 8, June 1931, 348 pp., 46 figs.

Photoelectric Cells

Photo Cells and Thyratrons, L. J. Davies. *Elecn.*, vol. 106, no. 2769, June 26, 1931, pp. 936-938, 8 figs. Growing importance of vacuum devices; elements of cell; properties of thyratrons.

Power Factor

An Elementary Discussion of Power Factor, J. Leech-Porter. *Can. Min. Jl.*, vol. 52, no. 23, June 1931, pp. 584-587, 3 figs. Preliminary contribution to question of power factor correction; principles of power factor, which are not very clear to men outside those who have specialized in electrical engineering, in simple and direct way.

Power Industry

Public Interest Demands Utility Merchandising. *Elec. World*, vol. 97, no. 25, June 20, 1931, pp. 1180-1181, 4 figs. Oregon utilities justify merchandising on grounds that consumers are entitled to maximum usage at minimum rates and furnish evidence proving that only through their activities has been made possible; graphs showing average annual use of electricity per domestic customers, average rate per domestic kw-hr., average annual kw-hr. use per domestic customer and decrease in average rate per domestic kw-hr.

Power Plants

STEAM-ELECTRIC. Foreign Developments. *Nat. Elec. Light Assn.—Pub.*, no. 131, May 1931, 38 pp., 53 figs. In general, trend of power-plant development is toward higher pressures and temperatures; American viewpoint of European situation is presented in composite statement of several engineers who attended World Power Conference, Berlin; peak-load problem; tendencies of modern German steam generation; trend of developments in central stations and equipments in England; Golpa-Zschornewitz plant of Elektrowerke Aktiengesellschaft; tests on Ruths accumulator plant in Charlottenburg power station. Bibliography.

Power Supply

NEW YORK CITY. The Power Behind New York—II. *Power Plant Eng.*, vol. 35, no. 13, July 1, 1931, pp. 702-707, 7 figs. Features of system operation; analysis and application of load curves; factors affecting system operation; determination of incremental rates; frequency and voltage regulation.

RURAL. A Report on Farm Electrification Research. *Committee on Relation Electricity to Agriculture—Bul.*, vol. 6, no. 1, June 1931, 79 pp. Progress of investigations of different types which have been conducted; analysis of agricultural development; major economic and production problems in which electricity may be involved; plan and program for continuation of research activities; investigations under way and proposed; work done and need for further investigations in that particular field.

Pumping

PETROLEUM PIPE LINES. Electricity in the Transportation of Oil, G. R. Prout. *Oil and Gas Jl.*, vol. 30, no. 2 to 4, June 4, 1931, (supp.) pp. T99 and T101, 7 figs. Review of reasons for tendency towards use of electric motors for pipe line pumping; gathering line and trunk line work; advantages of automatic operation; Diesel electric pumping stations; 160,000 hp. in motor capacity is now installed in oil pipe line stations in central and southwest United States.

Remote Control for Electric Stations, L. G. E. Bignell. *Oil and Gas Jl.* vol. 30, no. 2 to 4, June 4, 1931, (supp.) pp. T49-T50, 1 fig. Outline of control system devised by Westinghouse Electric & Manufacturing Co.; one station equipped in Oklahoma.

Motor Heat Controlled in New Sinclair Pump Station, J. C. Albright. *Oil Weekly*, vol. 62, no. 2, June 26, 1931, pp. 25-26, 4 figs. Oklahoma City-Coffeyville line booster stations are all alike in design and equipment, with two Byron Jackson three-stage oil line pumps, capacity 60,000 bbl. oil daily at 3,550 r. p. m.; each pump connected by Fast's self-aligning coupling to General Electric Type FT-559-AY form EL2,200-volt three-phase 60' cycle induction motor, delivering 500 hp.; normal operating temperature 104 deg. fahr.; provisions for air circulation and hot air disposal.

Radio

AIRPLANES. Some Considerations Affecting Design of Aircraft Wireless Equipment, J. A. McDonald. *Roy. Air Force Quarterly*, vol. 2, no. 2, Apr. 1931, pp. 258-269, 4 figs. on supp. plates. Reliability and type of apparatus for signaling between aircraft in flight and between aircraft and ground stations.

Temperature Rating of Engine Driven Aircraft Radio Generators, C. B. Mirick and H. Wilkie. *Inst. Radio Engrs.—Proc.*, vol. 19, no. 7, July 1931, pp. 1175-1181, 11 figs. Previously described methods of temperature measurement and computation are applied to engine driven aircraft radio generators in flight; observed and computed heating curves are shown from which emission constant for this type of machine has been derived.

AMPLIFIERS. High Audio Power From Relatively Small Tubes, L. E. Barton. *Inst. Radio Engrs.—Proc.*, vol. 19, no. 7, July 1931, pp. 1131-1149, 11 figs. Method by which audio outputs 5 to 10 times usual output of tube of given size may be obtained with same plate voltage, lower average plate dissipation, and no serious effects on tube; results are obtained by using in such manner that advantage is taken of essential features of class "B" amplifier.

Note on Radio Frequency Transformer Coupled Circuit Theory, J. R. Nelson. *Inst. Radio Engrs.—Proc.*, vol. 19, no. 7, July 1931, pp. 1233-1241, 4 figs. Equations considering effects of output and distributed capacities and primary resistance are developed for radio-frequency transformer-coupled amplifiers using either tuned or untuned primary; these equations are transformed to such form that they may be compared with well-known equations derived for untuned primary neglecting output and distributed capacities; equations for untuned primary are verified experimentally.

AMPLIFIERS—COUPLING. Maximum Amplification in Capacity-coupled Circuits, W. van B. Roberts. *Electronics*, vol. 3, no. 1, July 1931, pp. 20 and 42, 2 figs. In analysis given only two approximations are introduced and neither of these is believed to be capable of making appreciable difference in any ordinary circuit.

ANTENNAS, SHORT WAVE. Theoretical and Practical Aspects of Directional Transmitting System, E. J. Sterba. *Inst. Radio Engrs.—Proc.*, vol. 19, no. 7, July 1931, pp. 1184-1215, 19 figs. More important principles involved in development of directional transmitting antennas at present employed in Bell system short-wave facilities; theoretical performance of directive arrays is presented by means of various curves which have been obtained by integrations based upon Poynting's theorem; various practical problems in development including antenna tuning procedure, transmission line adjustments, and sleet melting facilities.

CIRCUITS—TUNING. Tuning by Permeability Variation, R. H. Langley. *Electronics*, vol. 3, no. 1, July 1931, pp. 8-10, 2 figs. Results of W. J. Polydorff studies and experiments by which is attained that variable air condensers are replaced by iron cores inserted gradually into radio frequency transformers; curve showing amplification and selectivity of screen-grid tube with iron core transformer; simple analysis is given.

COILS—DESIGN. Supplementary Note to the "Study of the High-Frequency Resistance of Single-Layer Coils," A. J. Palermo and F. W. Grover. *Inst. Radio Engrs.—Proc.*, vol. 19, no. 7, July 1931, pp. 1278-1280. Since publication of above paper in Dec. 1930 number, indexed in Engineering Index 1930, p. 1415, attention of authors has been called to two articles on a-c. resistance of solenoidal coils by S. Butterworth, which were overlooked in preparation of paper; tabulated results show that for coils measured, Butterworth's formula 30 gives best agreement with measured values in all except few cases.

DETECTORS. High Level Automatic or Self-Bias Detection, J. R. Nelson. *Electronics*, vol. 3, no. 1, July 1931, pp. 14-15, 3 figs. Circuit used for experimental determination of self-bias detection characteristics; calculation of rectified output; dynamic characteristics of typical self-bias detector; rectification curves of 27 detectors.

FREQUENCY—MEASUREMENT. Frequency Measurement in the British Post Office, F. E. Nancarrow. *Post Office Elec. Engrs.—Jl.*, vol. 24, pt. 2, July 1931, pp. 155-159, 4 figs. In radio department of British Post Office, all frequencies are measured by reference to harmonic frequencies of tuning-fork maintained in Radio laboratories at Dollis Hill, Lond.; this fork can be regarded as Post Office standard of frequency; fork and temperature control; pressure effect.

MEASURING INSTRUMENTS. Thermo-junctions at High Radio-frequencies, F. M. Colebrook. *Experimental Wireless*, vol. 8, no. 94, July 1931, pp. 356-361, 5 figs. Object of investigation was to obtain information about frequency variation of thermo-junction milli-ammeters; tube rectifier milliammeters was specially designed for purpose of inter-comparison of thermo-junctions investigated and vacuum tube instrument.

OSCILLATORS, PIEZOELECTRIC. Performance of Piezo-Oscillators and the Influence of the Decrement of Quartz on the Frequency Oscillations, M. Boella. *Inst. Radio Eng. Radio Engrs.—Proc.*, vol. 19, no. 7, July 1931, pp. 1252-1273, 21 figs. Performance of piezo oscillators of usual Pierce circuits is treated, on basis of resonance curves of quartz and with help of vector diagrams; influence of decrement of quartz resonator on oscillation frequency is examined; study has led to arrangement which permits quartz to oscillate in proximity to its frequency of resonance and to reduce thereby influence of decrement on frequency to about 1/10 of that usually found.

TRANSMISSION. Notes on Radio Transmission, C. N. Anderson. *Inst. Radio Engrs.—Proc.*, vol. 19, no. 7, July 1931, pp. 1150-1165, 16 figs. Considerable data on radio transmission have been obtained past few years in connection with establishment and operation of various radio-telephone services by Bell System; purpose of notes is to present certain aspects of some of these data which may be of interest in development of general physical picture of radio transmission and in indicating effects of disturbances accompanying storms in earth's magnetic field.

TUNING. Tuning by Permeability Variation, R. H. Langley. *Electronics*, vol. 3, no. 1, July 1931, pp. 8-10, 2 figs. Results of W. J. Polydorff studies and experiments by which is attained that variable air condensers are replaced by iron cores inserted gradually into radio frequency transformers; curve showing amplification and selectivity of screen-grid tube with iron core transformer; simple analysis is given.

Railroad

AUTOMATIC BLOCK SIGNALS. Committee VIII—Alternating Current Automatic Block Signaling, W. F. Follett. *Am. Ry. Assn.—Proc.* (*Signal Sec.*), vol. 28, no. 3, June 1931, pp. 487-490. Specifications covering made ground apparatus for lighting arresters; and oil-immersed self-cooled line transformers.

Committee IV—Direct Current Automatic Block Signaling, E. N. Fox. *Am. Ry. Assn.—Proc.* (*Signal Sec.*), vol. 28, no. 3, June 1931, pp. 490-500. Condensation of moisture and formation of frost on signal apparatus; direct current track circuit test record; plug type rail bonds and track circuit connectors; rail bond; plug type; track circuit connector; relay contact post designation plate.

INTERLOCKING SIGNALS. Committee II—Interlocking. *Am. Ry. Assn.—Proc.* (*Signal Sec.*), vol. 28, no. 3, June 1931, pp. 501-506. Car retarder system; electric motor switch operating mechanism; centralized traffic control system; centralized traffic control machine; electric look; time release; interlocking lever circuit controller.

ELECTRIC CONTROL SWITCHES. The Sheremeteff Electro-Gravity Point Mechanism. *Ry. Engr.*, vol. 52, no. 617, June 1931, pp. 214-215, 5 figs. partly on p. 224. Details of system in use on London and North Eastern, whereby wheels of passing train provide necessary energy for operating pair of points; wiring diagram of operating mechanism.

ITALY. The Bologna-Florence Direttissima Railway and the Great Apennine Tunnel. *Engineer*, vol. 151, no. 3936, June 19, 1931, pp. 676-680, 12 figs. Route has length of 97 km. with double track; maximum gradient is 1 in 83; stations are capable of accommodating trains 500 m. long; longest tunnels are Great Apennine, 18,510 m., Monte Adone, 7,135 m., and Pian di Setta, 3,045 m. long; longest viaduct is at Vado, carried on 14 arches, each of 20 m. span; ventilation and methods of driving tunnels; line will be electrified on three-phase system at 3,700 volts and 16⅔ cycles, current being supplied from converter station at San Viola, Bologna.

ELECTRIFICATION — LACKAWANNA. Lackawanna Railroad. *N. Y. Railroad Club—Off. Proc.*, vol. 41, no. 7, May 1931, pp. 9625-9660, 18 figs. Symposium of papers: Lackawanna Suburban Electrification in New Jersey, G. J. Ray; High Spots of Electrification on Lackawanna R. R., E. L. Moreland; Informative and Interesting Description of Sub-Stations and Construction of Catenary System, J. S. Thorp; My Experience with Commuters, J. J. Pierce; Multiple-Unit Cars, Three-Power Locomotives and Training of Employes for Delaware, Lackawanna and Western Railroad Electrification, E. E. Root.

SIGNALS AND SIGNALING. Committee X—Signaling Practice, W. M. Post. *Am.*

Ry. Assn.—Proc. (*Signal Sec.*), vol. 28, no. 3, June 1931, pp. 455-479. Automatic train control; locomotive cab signals; requisites for centralized traffic control system, automatic block signal system and interlocking system.

Rectifiers

JET WAVE. The Jet-Wave Rectifier; An Account of Its Constructional Development During the Years 1919-1929, no. 24, edited by J. Hartmann, Copenhagen, Danmarks Naturvidenskabelige Samfund I Kommission Hos G. E. C. Gad. *Vimmelskaftet* 32, 1931, 300 pp., figs., diagrs., 30 kr. General principles; jet; jet-wave; hydrodynamic circuit; magnet; auxiliary electrode; main electrode I; main electrode II; complete rectifier; rectifier plant; this research work has undertaken with view of developing high power rectifiers on basis of jet-wave principle; history of this principle and of its development before and after 1919 is given in appendix.

MERCURY-ARC. An Automatically-Controlled Rectifier on the London Underground Railway. *Engineer*, vol. 152, no. 3938, July 3, 1931, pp. 19-20, 7 figs. Rectifier installed by B. T. H. Co. in Hendon substation of London Electric Railway Co.; among special features, are: indestructible construction of anodes and anode enclosures, six-phase excitation, and accurate temperature control.

Mercury-arc Rectifiers, H. Rissik. *Elec. Rev.*, vol. 108, no. 2794, June 12, 1931, pp. 991-92, 6 figs. Recent developments in their application to heavy-duty work.

Refrigeration

Electric Refrigerators and Electric Refrigeration, C. H. Roe. *Ice and Refrig.*, vol. 80, no. 6, June 1931, pp. 473-474. Advent of electric refrigerators stimulated refrigeration industry; importance of information on performance and costs; standardization of household refrigerators. Before Nat. Electric Light Assn.

Resistance

GROUND. Guessing Ground Resistances Is a Risky Procedure, S. W. Borden. *Elec. World*, vol. 97, no. 25, June 20, 1931, p. 1172. Tests were made recently on steel tower line located where earth for some depth consists of sand and gravel; four tower legs, which form 15 ft. square, are buried directly in ground and each tower carries two three-phase, 66-kv. circuits; results of various measurements are given.

Substations

AUTOMATIC. Automatic Switching Equipment for Motor-generator Sets at the Campbell Works of the Youngstown Sheet & Tube Company, C. M. Myers and J. H. Graft. *Gen. Elec. Rev.*, vol. 34, no. 7, July 1931, pp. 431-435, 7 figs. Central substation was erected in 1926; in selection of switching equipment for motor-generator sets; location for equipment; attendants available; importance of maintaining continuous power on all feeders; simplicity of equipment; justifiable cost are to be considered.

DESIGN. Meeting Space Limitations in Urban Substations. *Elec. World*, vol. 97, no. 26, June 27, 1931, pp. 1224-1229, 18 figs. Various basic principles of design affecting space allocation and number of detailed features of economical treatment in equipment placement by power companies in eastern New England are cited; table showing clearances according to operating voltages; used by Boston Edison Co. station engineering department.

Substation Expansion Typifies Economy of Designing for Future Requirements, A. Shipek *Elec. West*, vol. 66, no. 7, June 1, 1931, pp. 610-611, 3 figs. Design features of terminal substations of Puget Sound Power and Light Co. Seattle, Wash.

Switchboards

SUPERVISORY CONTROL. Miniature Supervisory Control Gives Creditable Performance, R. M. Stanley, *Elec. World*, vol. 98, no. 1, July 4, 1931, pp. 22-25, 2 figs. With miniature switchboard operator is at all times closer to indicating instruments, control switches, etc., and can give better and closer supervision to operation of equipment, resulting in better voltage control, frequency control and division of load among generating units; there is great saving in time during regular operation and human error is largely eliminated. Before Am. Inst. Elec. Engrs.

Switchgear

Switchgear, H. Astbury. *Engineer*, vol. 151, no. 3936, June 19, 1931, p. 680. Discussion on rupturing capacity of extra-high-tension and low-tension switchgear to be installed on customers' premises. Before Instn. Elec. Engrs.

Telephone

AUTOMATIC. Common Control System, R. Taylor and C. E. Beale. *Post Office Elec. Engrs.—Jl.*, vol. 24, pt. 2, July 1931, pp. 125-131, 6 figs. In Common Control System, transitory functions are performed by detached groups of relays, each group being arranged to control number of switches; to switches themselves are fitted only relays that are required for full duration of call, plus one relay that serves to link up with common control group during setting up of call.

CONDENSERS. Telephone Condensers, R. E. W. Maddison and S. Chapman. *Elec. Communication*, vol. 10, no. 1, July 1931, pp. 39-44, 3 figs. Production and properties of paper condensers, no theories of dielectrics are included; electrodes; paper; materials; impregnating medium; process of manufacture; "Mansbridge" Condensers; electric properties; capacity; power losses; life tests.

RELAYS. Characteristics of Strowger Relays, K. W. Graybill. *Telephone Engr.*, vol. 35, no. 6, June 1931, pp. 30-31, 4 figs. Various methods used to determine mechanical adjustment values of horizontal relays together with reference tables governing these values.

TRANSOCEANIC. International Telephony, H. S. Osborne. *West. Soc. Engrs.—Jl.*, vol. 36, no. 3, June 1931, pp. 148-160, 9 figs. General description of apparatus and characteristics of its operation.

Testing Apparatus

HIGH TENSION. High-Voltage Testing Equipments, E. T. Norris and F. W. Taylor. *Instn. Elec. Engrs.,—Jl.*, vol. 69, no. 414, June 1931, pp. 44-694, 26 figs. State of art of high-voltage generation, to assist intending purchasers of high-voltage testing equipments in deciding upon best type of apparatus to install and in specifying most suitable technical characteristics, and to help owners and operators of existing equipments to appreciate possibilities and limitations of their apparatus and thereby make full and efficient use of it. Bibliography.

Transformers

TAP CHANGERS. Transformer Tap Changing on Load. *Engineer*, vol. 151, no. 3937, June 26, 1931, pp. 704-706, 13 figs. With view to meeting demand for step switches for pressure regulation on Load, Oerlikon Co. has utilized its experience gained in connection with traction gear, and has evolved various types of apparatus.

VAULTS. Typical Construction in Underground Transformer Installations, J. D. Pease. *South. Power Jl.*, vol. 49, no. 6, June 1931, pp. 57-58, 3 figs. Constructional features of three installations of commercial and industrial transformer stations in underground rooms.

Transmission

Is A-C. Power Transmission Doomed? C. W. Olliver. *Power Engr.*, vol. 26, no. 303, June 1931, pp. 210-211 and 229, 2 figs. A-C. power transmission was necessary evil, imposed by impossibility of static transformation; recent progress, by removing this obstacle, may well turn a-c. transmission lines into relics of past; series systems; field of application of d-c. generating system; advantages of d-c. long-distance transmission.

Transmission and Distribution

Transmission and Distribution, J. R. Beard and J. Hacking. *Instn. Elec. Engrs.—Jl.*, vol. 69, no. 414, June 1931, pp. 730-750. Brief account of present-day practise in regard to various component parts of transmission and distribution systems; subjects are dealt with under heads: overhead lines; cables; switchgear; transformers; protection and control. Bibliography.

Transmission Lines

CONSTRUCTION. Construction Methods in Erecting Hydro 220,000-v. Transmission Lines, G. R. Greer. *Elec. Canada*, vol. 8, no. 3, Mar. 1931, pp. 10-17, 8 figs. Construction experience and methods on line Catineau-Toronto in Canada.

TOWERS. Transmission Tower Design for Maximum Lightning Protection, C. L. Fortescue. *Elec. Canada*, vol. 8, no. 3, Mar. 1931, pp. 18-23, and 32, 8 figs. Design analysis, curves showing effect of ground resistance with surge at tower for two and three ground wires; comparison of time-lag curves or sphere gaps and needle gaps; method of finding effective distance from ground wire to cloud; suggested arrangements when two ground wires are used; extrapolated average time-lag curves for needle gaps in air; time-lag curves of suspension insulators, with conductor positive.

Trolleys

TRACKLESS. The Trolley Bus as a Load Builder. *World Power*, vol. 15, no. 90, June 1931, pp. 465-469, 12 figs. Question of substituting trolley-bus or motor-bus service for street-car system; overwhelming economic advantages of trolley-bus service; analysis made of significance of street-car; load to electricity supply position in general and to municipal undertaking in particular.

Turbo-Generators

ROTORS. Turboalternator Rotors, W. R. Needham. *World Power*, vol. 15, no. 89, May 1931, pp. 375-376. General progress in rotor construction; influence of mechanical stresses on design.

U. S. INTERSTATE COMMERCE COMMISSION. Engineering in Its Relation to the Interstate Commerce Commission, F. McManamy. *Mech. Eng.*, vol. 53, no. 7, July 1931, pp. 503-509. Creation, organization, and duties of Commission; work of its various bureaus, including services of engineers in valuation, analysis of expenditures for equipment maintenance, and extensions; examination of specifications for locomotives, safety devices, etc.; determination of suitability of containers for transportation of explosives, etc. Before Am. Soc. Mech. Engrs.

Vacuum Tubes

RESEARCH. Electronic Tubes in the Laboratory. *Electronics*, vol. 3, no. 1, July 1931, pp. 24-25, 4 figs. Symposium of short notes by W. O. Watson, on Calibration of Grid Gain Controls; Glow-tubes Check Operating Voltage, by Gray Telephone Pay Station Co.; Progress in South Analysis and Measurement, F. Trendelenburg, of Siemens, Berlin; Graphic Noise Level Recorder, by Bell Telephone Laboratories.

Welding

BOILER MANUFACTURE. Boiler Manufacturers Discuss Welding at Annual Meeting. *Boiler Maker*, vol. 31, no. 6, June 1931, pp. 151-157. Application of fusion welding to construction of boilers and pressure vessels discussed at convention of American Boiler Manufacturers' Association; charts summarizing production of steel boilers from 1919 to 1930 inclusive; smoke prevention conference committee; cost accounting committee report; auxiliary equipment; work of feedwater studies committee; report of welding committee and discussion.

HOUSES, STEEL. An Arc-Welded Residence. *Gen. Bldg. Contactor*, vol. 2, no. 7, July 1931, pp. 33-36, 4 figs. Construction of two-story, six-room dwelling erected of arc-welded steel panels at Larchmont, N. Y.

PIPE LINES. Progress Made in Electric Arc Welding, C. M. Taylor. *Oil and Gas Jl.*, vol. 30, no. 2 to 4, June 4, 1931, (supp.) pp. T115-T116 and T118, 10 figs. Advantages of new welding process are explained by vice president of Lincoln Electric Co.; shielded arc produces welds of high tensile strength, ductility and resistive to corrosion; greater welding speed is obtained.

PRESSURE VESSELS. Fusion Welding and Its Use in Pressure Vessel Construction, W. D. Halsey. *Boiler Maker*, vol. 31, no. 5, May 1931, pp. 125-126. Because of recent rapid development in fusion welding, American Society of Mechanical Engineers' Boiler Code Committee has in course of preparation, code covering use in pressure vessel construction; attitude of insurer of such vessels towards process, and procedure to be followed in applying coverage for installations of such character.

SHIPBUILDING. Welded Machinery Foundations for Ships, G. H. Moore, Jr. *Welding Jl.*, vol. 28, no. 333, June 1931, pp. 172-175, 15 figs. Paper before Am. Welding Soc. previously indexed from their Journal, Apr. 1931.

Welds

STRESSES. The Distribution of Stresses in Welded and Riveted Connections, W. Hovgaard. *Nat. Academy Sciences—Proc.*, vol. 17, no. 6, June 1931, pp. 351-359, 6 figs. Results of tests made at Massachusetts Institute of Technology; fundamentals of method. See reference to paper indexed in Engineering Index 1930, p. 1900, from issue of Nov. 15, 1930.

Industrial Notes

Carbon Brush Dimensions to be Simplified.—A meeting of the standing committee in charge of Simplified Practice Recommendation R56-28, Carbon Brushes and Brush Shunts, was held at the office of the National Carbon Company in Cleveland, Ohio, on July 28, 1931. Those present represented manufacturers of carbon brushes and brush shunts, motor and generator manufacturers, and users of motors and generators. The committee voted to reaffirm all items in the present recommendation with the exception of brush dimensions. In the opinion of the members, a further simplification of dimensions could be agreed upon by all parties concerned within the next few months. The committee therefore voted to hold in abeyance the publication of a revised recommendation until the new list, showing a smaller number of brush dimensions, had been approved by manufacturers of brushes, and of motors and generators. It is expected that this will be done within the next three months, and will result in largely reducing the number of stock items catalogued by all manufacturers.

The committee further voted to include in the revised recommendation certain additional definitions, together with a table showing the nomenclature recently adopted by the brush manufacturers to indicate the various standard types of shunt connections. It is also hoped that a further reduction can be made in the number of shunt lengths. Some of the manufacturers have already reduced the number of lengths from six to three. As soon as the necessary approval has been secured from the various associations interested, the final revision will be submitted to the division of simplified practice, which will then undertake to secure the written acceptance of the entire industry, in accordance with the regular procedure.

Pittsfield to Build Largest Transformers.—The largest transformers ever built at the Pittsfield works of the General Electric Company will be constructed for the Commonwealth Edison Company of Chicago and the Super Power Company of Illinois as part of an order for more than $1,000,000 worth of equipment. Delivery of the 20 transformers involved is expected early in 1932. So large are eight of the units that special drop-frame transformer cars must be built to ship them. The transformers will be used on both ends of a new 220,000-volt transmission line extending about 100 miles from Powerton to the Crawford Avenue station of the Commonwealth Edison Company at Chicago. For the receiving end, there will be required four 67,500-kva. power transformers and four 50,000-kva. regulating transformers. The power units, the heaviest, will weigh 491,000 pounds each, filled with oil.

Physically they will rival other big units made at the Pittsfield works in recent years. They will be 30 feet high overall, 27½ feet long and 19½ feet wide. In addition to these power units for the receiving station, there will be four regulating units, of 50,000-kva. output each, somewhat smaller in size and weighing 146,000 pounds each. At the sending end of the line there will be four 600,000-kva. units, weighing 406,000 pounds each, and eight 30,000-kva. regulating transformers weighing 75,000 pounds each.

Large Switch Order to Delta-Star.—The Pennsylvania Railroad Company has awarded the Delta-Star Electric Company, Chicago, a $150,000 contract for manual and motor operated disconnecting switches to be used on the railroad's extensive electrification project.

New Cap Type Connector.—The W. N. Matthews Corporation, St. Louis, announces the addition of cap type connectors to its line of solderless service connectors. Matthews connectors are now made in two styles, the new cap type and the nut type. The following advantages are claimed for the new connector: There are only two pieces to handle; the clamping lugs are made of bronze; hard drawn copper wire instead of soft drawn wire may be used. Bad connections are eliminated; it can be used much more economically for heavy loads where twisting large wires is difficult; radio interference due to twisted tap wires becoming loose is eliminated, because positive contact is assured and vibration will not cause loosening of the connector.

New Friction Tape.—The mechanical sales division of the B. F. Goodrich Company recently announced the development of a new friction tape especially designed for electrical use. The tape is similar to inner type patching material and practically vulcanizes in place after applied, making a solid covering for wire. The tape is listed by insurance underwriters and is approved for electrical purposes as taking the place of both insulating material and ordinary cloth tape, according to the manufacturer. The tape is so designed that it can be rolled lengthwise around electrical conductors, and is especially applicable to wiring where it is difficult to wrap the wire. It is made in ¾ inch and 1½ inch widths, packed in rolls.

Trade Literature

Wire Rope.—Catalog, 280 pp. Describes the complete line of Roebling wire rope and wire for all purposes. Wire tables are included. John A. Roebling's Sons Company, Trenton, N. J.

Panelboards.—Bulletin CA-505-A, supplement, 8 pp. Describes new Square D shallow type convertible safety panelboards with capacities up to and including 100 amperes, 250 volts. Square D Company, Detroit.

Speed Regulators.—Bulletins 1101, 1102. Describe ventilated and totally enclosed type speed regulators for use with constant torque and variable torque a-c. and d-c. fractional horsepower motors. Ward Leonard Electric Company, Mt. Vernon, N. Y.

Metal Enclosed Switchgear.—Circular 1915, 12 pp. Lists the installations of Westinghouse metal enclosed switchgear, includes photographs and descriptions. Circular 1899, 8 pp., describes this class of equipment in detail. Westinghouse Electric & Mfg. Company, East Pittsburgh.

"Frog Leg" Type Armature Windings.—Bulletin 2135, 4 pp. Describes this type of armature windings for multipolar, direct-current generators and motors. Such windings have been installed to date in over 500 units ranging in size from 50 kw. to 7,000 hp., totalling approximately 400,000 kw. Allis-Chalmers Manufacturing Company, Milwaukee.

Switchboards.—Bulletin 700, 90 pp. Includes specifications and design of Diamond "E" and Square D switchboards and panelboards. A detailed group of recommendations are outlined for dead front, live rear and dead front, dead rear switchboards and power panels. Diamond Electrical Manufacturing Co., 1318 E. 16th St., Los Angeles.

Insulators.—Catalog. Describes the complete line of Lapp insulators. It contains full data on electrical and mechanical characteristics, together with suggested applications. Insulator hardware is also covered. The catalog has an automatic index which enables the user to quickly find the product sought. A special section on distribution and farm lighting equipment is included. Lapp Insulator Company, Inc., LeRoy, N. Y.

Out of the experienced past, into the exacting present, KERITE wires and cables through three-quarters of a century of successful service, continue as the standard by which engineering judgment measures insulating value.

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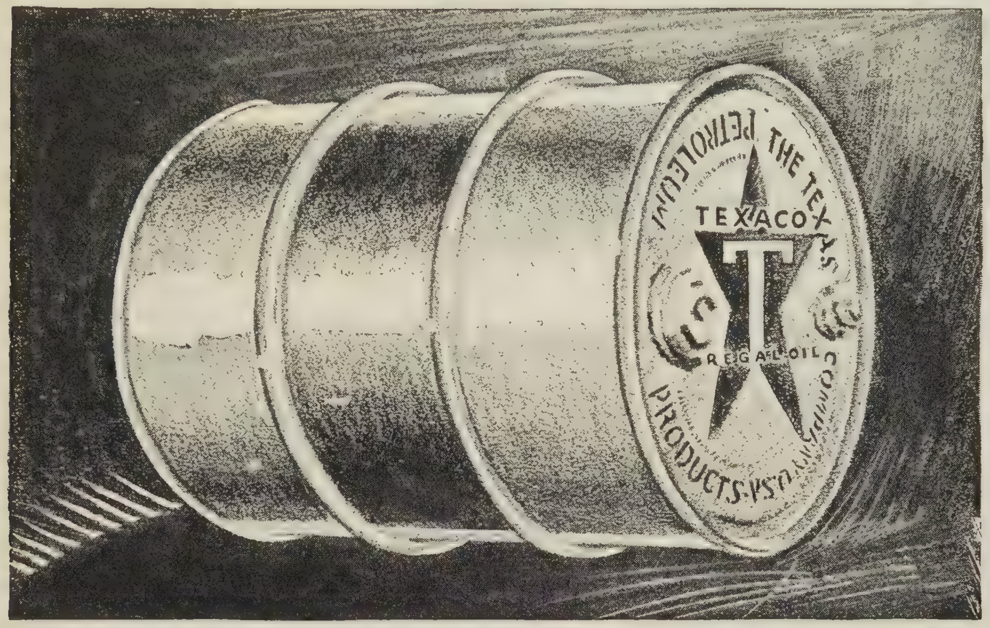
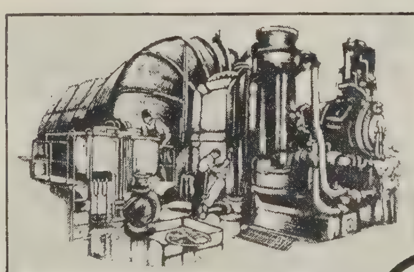


MANY things can happen to a turbine lubricant. The value of that lubricant over a period of years and the cost of turbine lubrication depend on how well the oil resists physical change and holds the effective lubricating qualities unimpaired. Nothing less than the finest turbine oil the market affords is good enough for these important power units. • Texaco Regal Oils are notable for their resistance to oxidation, emulsification and sludging. They are free from all gum-forming impurities. They are used today in a large percentage of the country's turbine operated power plants. • The quality of these oils, combined with the regular periodic laboratory check-up, which is a valued part of Texaco Lubrication Service, insures the highest type of effective lubrication always. • You will find that the proper grade of Texaco Regal Oil will entirely eliminate lubrication difficulties and uncertainty. There is a viscosity for every type and size of turbine, and Texaco lubrication engineers will gladly help you specify exactly the right grade for your machines.



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THE TEXAS COMPANY
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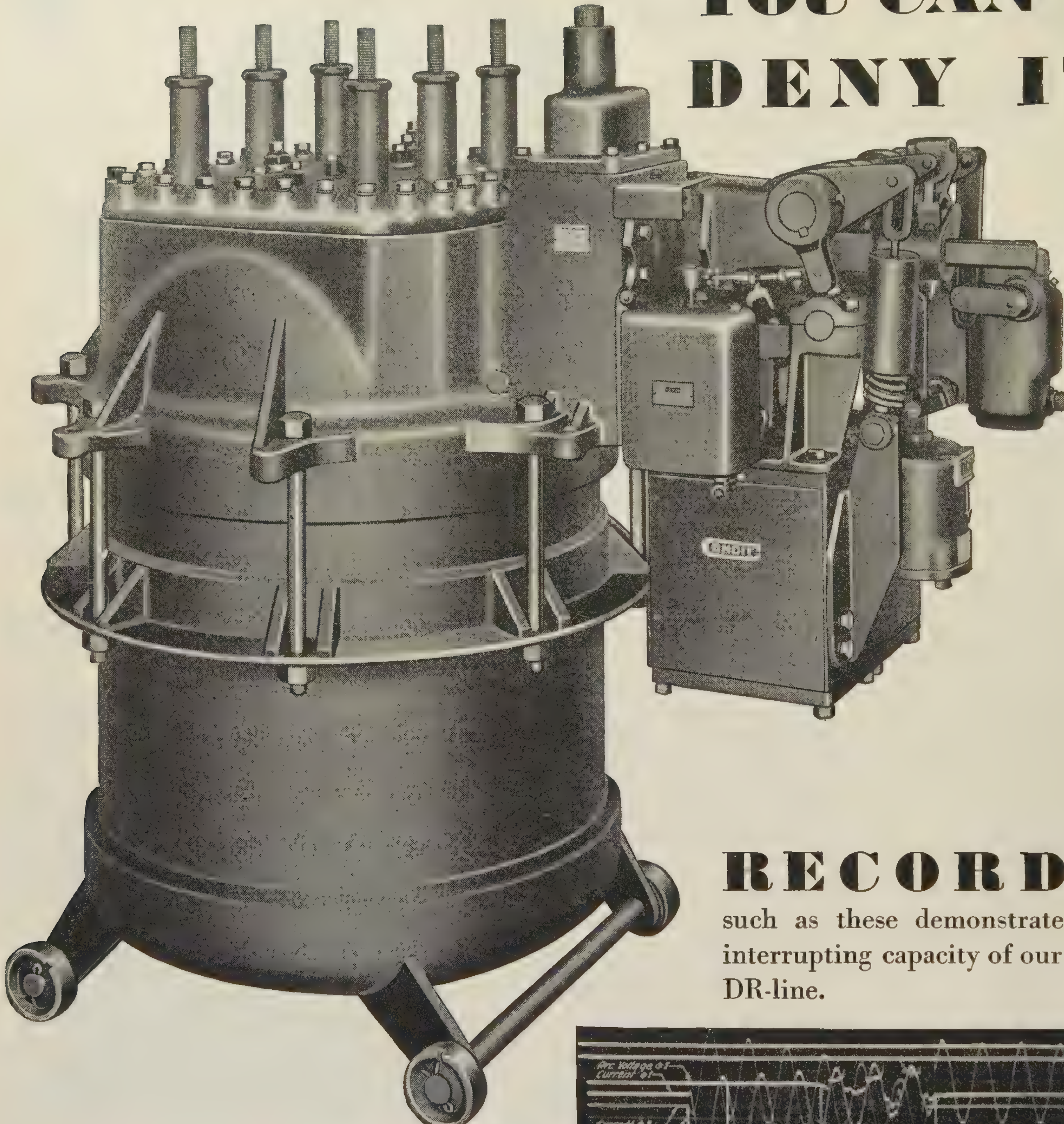

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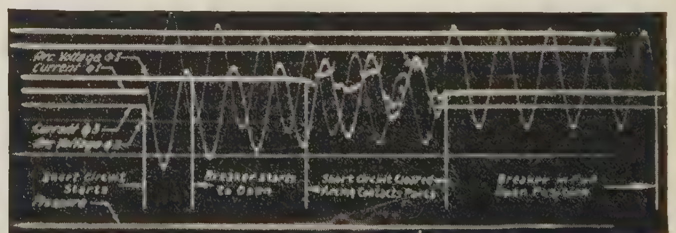
such as these demonstrate the interrupting capacity of our new DR-line.



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Types DR-25, DR-40, DR-60, DR-100 and DR-140, 15000 volt service or less

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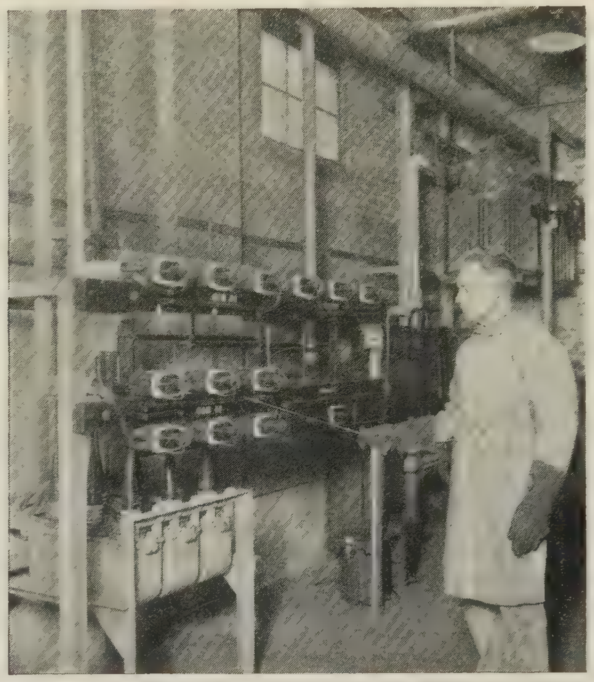
Safety Devices for the Protection of the Electrical Worker

STATION TYPE

Recommended for use in Stations and Substations.

Made from hard rubber rod, 24 inches long. Gives positive indication on 2000 volts and up.

Direct contact is not necessary as the instrument will indicate at a distance.



STATION TYPE—indicating on outside of 2300 volt rubber-covered insulated wire. Direct contact is made with the outside of insulation.

Pocket, Station and Overhead Statiscopes

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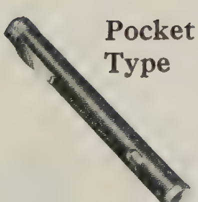
Send the coupon for details



Pocket Type

MINERALLAC ELECTRIC COMPANY
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Gentlemen: Please send me complete details of your Minerallac Statiscopes.

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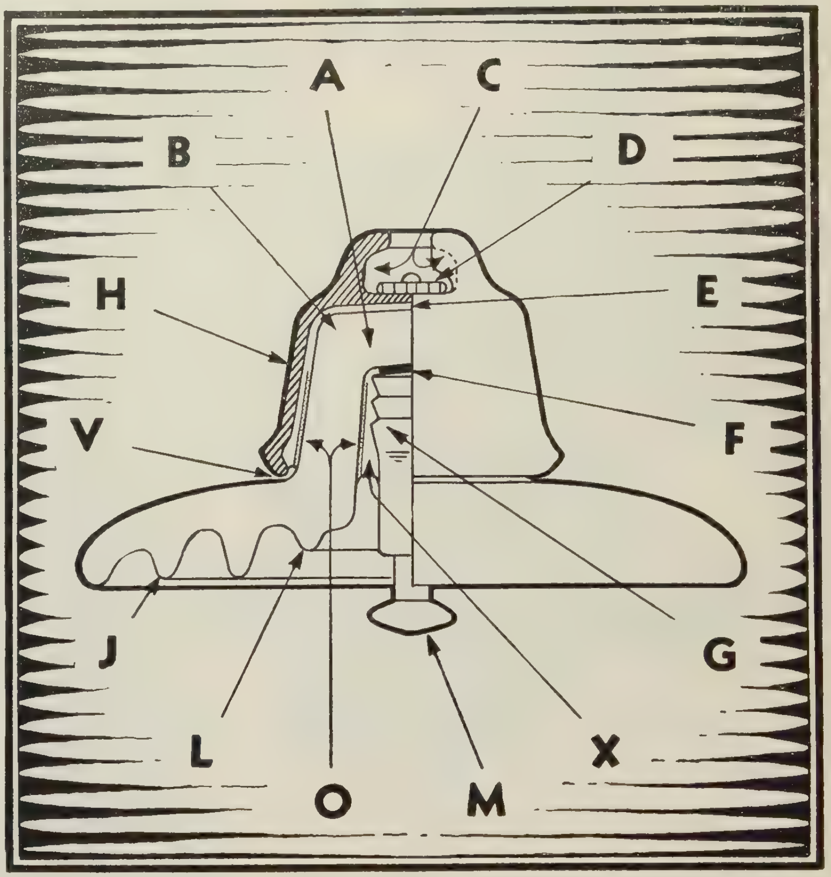
"...several things you should know.

Insulators aren't made by guesswork or by some unfounded theory. At least good insulators aren't. Now here are some of the factors that have contributed largely to the satisfactory performance of Locke Insulators:



A. Porcelain body—practically unchanged for fifteen years.

B. Full cornered head giving full electrical strength at a critical place.

C. Socket type insulators have a specially designed deep socket which prohibits accidental uncoupling.

D. Standard cotter key in socket type insulators. Both leg ends bent holding key central. Cannot be pulled all way out.

E. Resilient compound allowing cap alignment under load and freedom from damage under temperature changes.

F. Washer of resilient material. Prevents damage from accidental blows on bolt in shipment or handling.

G. Multiple stepped bolt used by Locke with no change for sixteen years.

H. Cap shaped by test to give best load distribution to porcelain.

J. Corrugations rugged—not easily chipped.

L. Short corrugation clears cap below and prevents radio interference.

M. Ball bolt turned true from specification copper-bearing steel. (Load pound value 80,000 lbs. per square inch minimum). Eye bolt in clevis type insulators produced by special machinery from same stock.

O. Sanded reglazed surfaces coated with a resilient compound to increase strength.

V. Expansion joint between cap and porcelain.

X. Cement of minimum radial thickness. Surface water-proofed to prevent possibility of water entering the pores of the cement and freezing. Coating also retards corona formation.

Those aren't just so much sales talk. They're features which have been definitely proved by time. Insulators of this general design have been giving one hundred per cent satisfaction for almost twenty years. And the standards that made this performance possible are standards which we shall always maintain.

LOCKE PORCELAIN INSULATORS

LOCKE INSULATOR CORPORATION . . . . . BALTIMORE, MARYLAND

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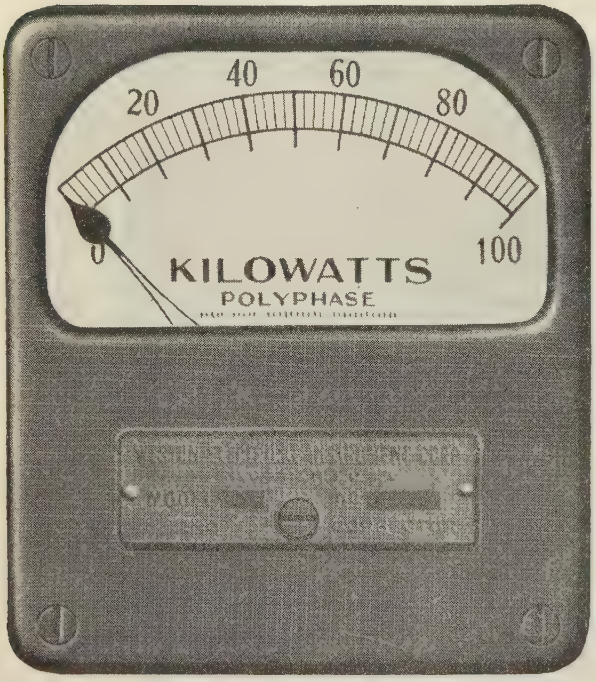

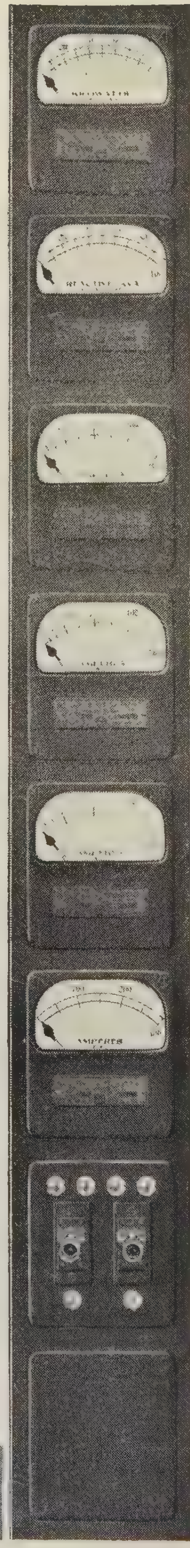

with WESTON MINIATURE CONTROL UNITS

Installation, operating and inspection costs are all cut to a new standard of economy by Weston Miniature Control Units. Besides, they increase efficiency by still further reducing the risk of "human error" by station attendants.

Weston Miniature Control Units, themselves, form the instrument panel. Built like a skyscraper—mounted on a rugged, spot-welded angle-iron frame—they save space, time and labor, and for the first time eliminate panel costs.

With each unit only five inches wide, an equal number of circuits is controlled within one-fifth of the usual space. One attendant has five times as many instruments and control switches within arm's length. Closer supervision and quicker operation.

Inspection takes less time and work with these new Units. It is safe, easy, convenient. Instrument and instrument transformer connections are accessible at the front of the Units. Instrument calibrations are checked from the front of the board without removing connections at the back.

This combination of economy and efficiency reflects the Weston experience of many years with central station problems, and advances switchboard construction to an entirely new phase of money-saving simplicity.

★ FEATURES OF WESTON MINIATURE CONTROL UNITS

1. Reduced initial cost—no awkward or costly panel.
2. Reduced operating cost—one attendant can handle five times as many circuits.
3. Closer supervision—control of five times as many circuits in the same panel length.
4. Reduced "human error"—operator closer to instruments and control switches.
5. Quicker operation—more compact centralization of control.
6. Saves space—80% less space needed.
7. Ease and speed of installation—units shipped completely wired ready to connect to external circuits—additional units simply bolted on.
8. Flexibility of arrangement—all parts interchangeable and standardized as to size.
9. Practical freedom from maintenance—Weston's inimitable, sturdy, precise construction.
10. Ease of repair when damaged by unusually severe service—complete movement assembly easily removed.
11. Ease of inspection—all instrument and instrument transformer connections accessible at front of board.

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Pioneers Again!

3 MAJOR DEVELOPMENTS IN AIR CIRCUIT BREAKERS

1. Min-Arc-Ite

The Arc Extinguisher with the True I-T-E Principle

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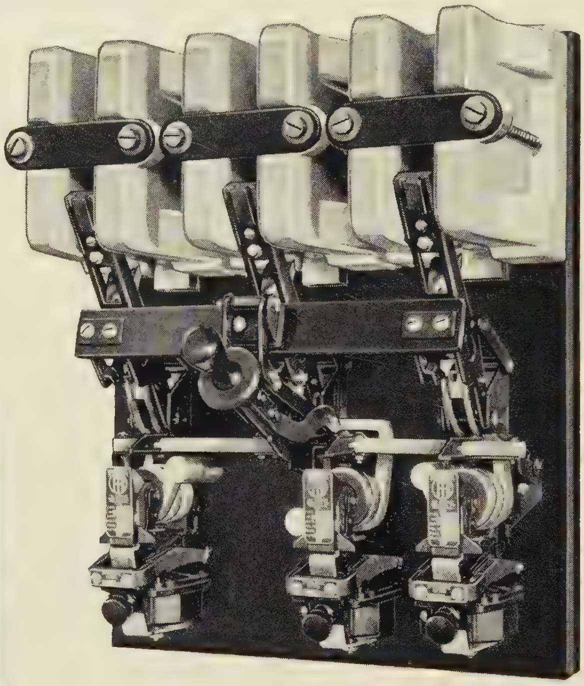
Min-Arc-Ite



With
Min-Arc-Ite

TO meet the ever increasing demand for higher interrupting capacities and shorter luration of arcs, emphasized by the enclosing of ircuit breakers in steel switchboards, I-T-E has leveloped the Min-Arc-Ite Arc Extinguisher—suitably arranged field coils embedded in molded asbestos barriers of the plug-in type, easily removable for access to the carbon supports.

Min-Arc-Ite Barriers are new in their application to the entire line of I-T-E Circuit Breakers and U-Re-Lites, but three years old in proven performance—and backed by forty-two years of experience in Air Circuit Breaker design.

The Min-Arc-Ite "effect" promptly interrupts the arc without undue voltage disturbance.

This is effected:

1. By quickly stretching the arc beyond its critical length.
2. By the cooling effect of the side walls of the barriers.
3. By the cooling effect (similar to the principle of mechanical refrigeration) of the sudden expansion of the gases at the barrier mouth.
4. By moving the arc rapidly through the air—as a match is extinguished.

Min-Arc-Ite Barriers are standard for 440 and 550 volts on Junior, Senior and type W, U-Re-Lites and on type LX U-Re-Lites and all types of I-T-E Circuit Breakers, when specified.

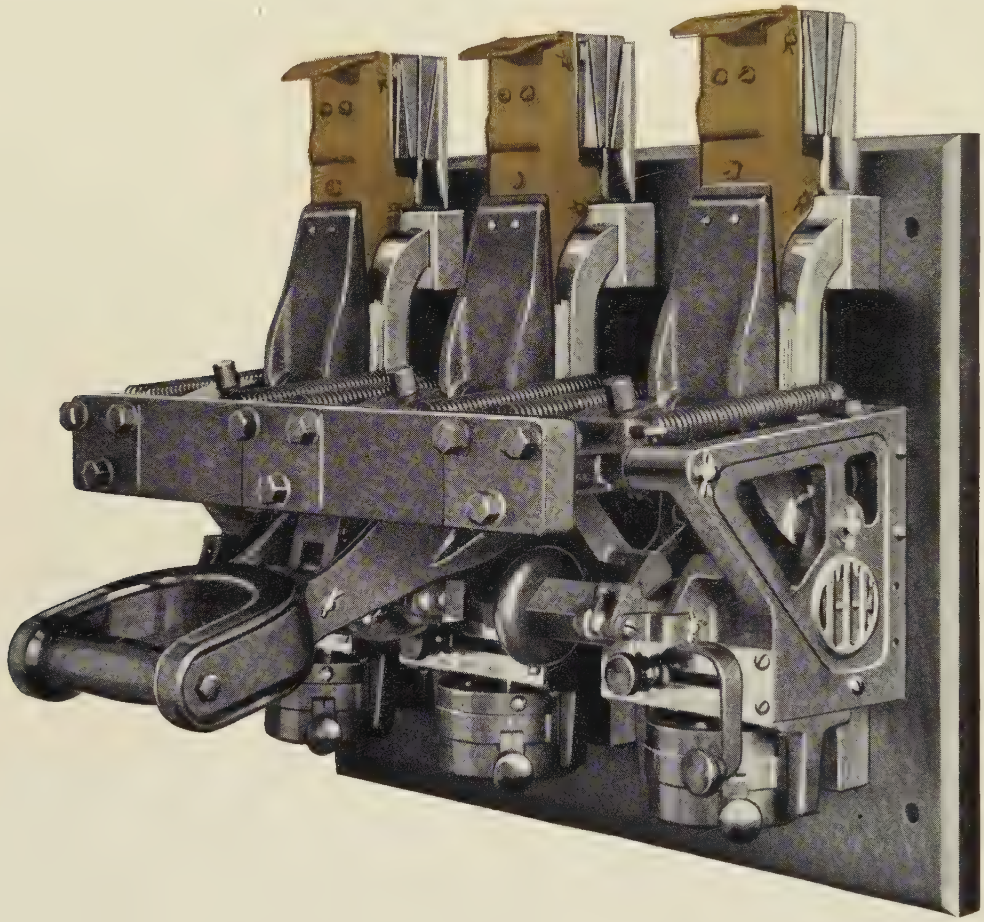
Min-Arc-Ite Arc Extinguishers:

1. Materially decrease size and time of arc (arc-watts) see comparative photographs above.
2. Materially reduce amount of ionized gases emitted on short circuits.
3. In combination with Re-Ax-Ite Carbon Supports materially add protection to main contacts and speed the opening of breakers.
4. Are *equally* as effective for D. C. as for A. C.
5. Increase the rupturing capacity of Circuit Breakers and U-Re-Lites and thus increase the factors of safety—owing to the fact that the standard large break distance is maintained.

★The Min-Arc-Ite arc extinguishing "effect" increases as the square of the current, operating on

2. Re-Ax-Ite

The Carbon Support with the True I-T-E Principle*



TESTS of standard circuit breakers on heavy short circuits (25,000 to 100,000 amperes at 550 volts) proved that the rupturing capacity was limited by the amount of current which distorted the arcing contacts, due to the powerful magnetic effect.

To avoid this limitation the Re-Ax-Ite Carbon Supports have been developed by I-T-E and are now standard construction on its entire line of breakers.

Re-Ax-Ite Carbon Supports are of stiff channel construction which successfully resists the magnetic forces; the latest development of a magnetic principle established by I-T-E thirty-one years ago. This assures that the second break is made on the shunt contacts and the final break on the carbons, at any magnitude of short circuit.

Re-Ax-Ite Carbon Supports:

1. Speed the opening of circuit breakers on short circuits.
2. Increase the rupturing capacity of circuit breakers by affording positive protection to the main contacts.
3. In combination with Min-Arc-Ite Barriers provide the positive high interrupting capacity demanded by the ever increasing capacity of electrical systems and the rapidly growing use of steel enclosed switchboards.

*The Re-Ax-Ite is based on the true Inverse-Time-Element principle—the heavier the short, the quicker the speed of opening—and the more positive the protection of the main contacts.

I-T-E Pioneers Again!

3. Dual Overload

Discriminating Overload Protection with the True I-T-E Principle*

DUAL Overload, exclusive with I-T-E, *discriminates* between desired overloads (such as current peaks in starting A. C. motors across-the-line) and non-desired overloads or short circuits, which must be cleared from the system instantly.

The unique design of the I-T-E Dual Overload achieves this discriminating, selective action by means of series overload coils equipped with two armatures per coil.

The *inside* armature is restrained by the direct acting time-delay (Dalite) and will hold the breaker closed during the starting period overload—if this overload persists beyond a safe limit the Dalite oil film will rupture, allowing the armature to trip the breaker.

The *outside* armature is calibrated to trip the breaker *instantly* on eight to ten times the motor running current, or on short circuit—independently of the action of the time-delay restrained armature.

The two armatures are independent of each other, but are acted upon by the same overload coil which is in series with the load, and therefore accurately reflects the total current flowing.

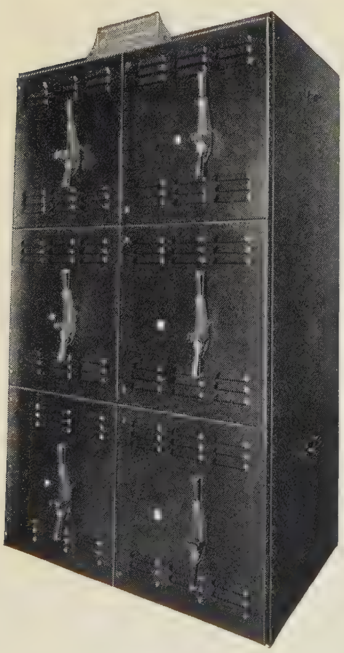
I-T-E Dual Overload Protection is:

1. Positive and accurate—due to series overload coils.
2. Discriminating and selective—due to double armatures.
3. The most dependable device for starting A. C. motors across-the-line, with full protection against sustained overloads and instantaneous opening on short circuit.

Dual Overload is standard on Junior, Senior and type W, U-Re-Lites.

★ The heavier the "desired" overload, the quicker the Dalite oil film will be ruptured, allowing the *inside* armature to trip the breaker. The heavier the short circuit, the quicker the *outside*, instantaneous armature will trip the breaker. Thus both armatures of the I-T-E Dual Overload operate on the true Inverse-Time-Element principle.

Multumite All-Steel Switchboards



UTILIZING its experience gained in twelve years of building steel-enclosed circuit breakers, U-Re-Lites—I-T-E has pioneered in the design and production of steel-enclosed switchboards.

In the short period of two years, 237 Multumite all-steel switchboards, protecting and controlling from six to a hundred circuits each, have been built for steam-electric plants, hydro-electric plants, railroad stations, theatres, office buildings and hotels; and for factories producing motor cars, cameras, ships, cash registers, chemicals, rubber, cement, oil, coal, steel and sugar.

Write for the Multumite book—completely describing and illustrating these modern switchboards.

And Silver-Plated Terminals

TO minimize the effect of oxidation and decrease circuit breaker maintenance, I-T-E now silver-plates the upper and lower terminal faces where they make contact with the main current carrying members. The male and female separable contacts in Multumite-Hingite steel switchboards are also silver-plated.

Silver-plating is standard on types LG, LL and LX circuit breakers and can be supplied on type W. The smaller types do not require this special treatment.

Silver-plating is an I-T-E extra value—at no extra cost to you.

I-T-E CIRCUIT BREAKER CO. · PHILADELPHIA, PENNA.

Outrunning fire *with* Radio

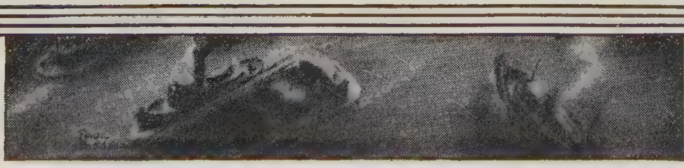
Fire is fast but radio is faster. Today the fire-boat with Western Electric Radio picks up the alarm instantly and has every chance of reaching the place before the flames have run far.

This equipment keeps the chief within voice range of his boats that patrol the waterfront. From headquarters or from the scene of the fire, he can direct them as closely as he does the engines on land.

Fire-boat radio is only one of several timely developments which Western Electric is making for marine use. Radio for fishing fleets, for tugs and lighters, for ferry boats serves a field where the need for instant communication is often urgent. And all this apparatus comes out of fifty years' experience in making telephones.

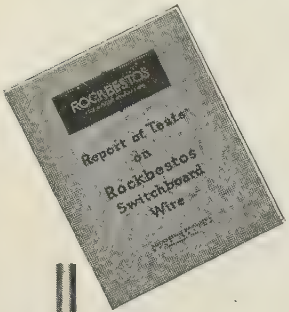
Western Electric

Makers of your Bell telephone and leaders in the development of sound transmission



A fast radio alarm gives the fire-fighters a valuable weapon—time

If you Write Specs on Swbd. Wire



DO your specifications still call for a straight varnished cambric switchboard wire with the usual gray or black flameproof cotton braid?

If they do, why not modernize them by calling for the switchboard wire that was designed to meet modern methods of wiring boards with sharp, square bends?

Instead of using five or six layers of varnished cambric tape (the usual method) ROCKBESTOS originated the idea of using only two tapes and building up the rest of the insulation thickness with a wall of dense, firm, resilient felted asbestos. You can see this wall just beneath the braid in the illustration.

When a sharp bend is made in ordinary switchboard wire, great strain is imposed on the cotton braid which elongates on the outside of the bend and pulls down tightly on the cambric insulation beneath it in so doing. The insulation, being comparatively stiff and unyielding, is usually stronger than the braid and since something has to give it usually is the braid, resulting in spoiled appearance.

Now in ROCKBESTOS switchboard wire, all this strain is taken off the braid by the felted wall of asbestos lying just beneath, which compresses as the tension on the braid increases, making it unnecessary for the braid to crack. Instead, a beautifully smooth bend results.

ROCKBESTOS switchboard wire costs no more than ordinary old fashioned switchboard wire, handles quicker and gives you far better work and satisfaction. Absolutely fireproof, too.

Let us send you the complete illustrated report and a sample of the wire. No obligation. Use the handy coupon. Drop it in an envelope and mail today.

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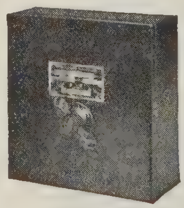
Speed Regulators

Bulletin 1101, Type B, Ventilated Speed Regulator.

Bulletin 1102, Type A, Totally Enclosed Speed Regulator with lever operating handle.



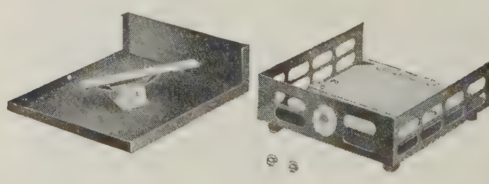
Bulletin 1102, Type B, Totally Enclosed Speed Regulator with knob operating handle.

SPEED REGULATORS that meet all the requirements of the critical buyer who demands economy with satisfactory performance.

Bulletin 1101 and 1102 Speed Regulators have style and economy in addition to the many features of Ward Leonard standard of quality.

Ventilated and totally enclosed types for fractional horsepower D.C. and A.C. motors are included in this line of speed regulators for fan and machine duty.

For larger capacities Ward Leonard Vitrohm Speed Regulators, Bulletin 1200 and 1300 for D.C. and Bulletin 2200 for A.C., have been the choice of experienced users. Write for descriptive literature on these and other Ward Leonard products.



Bulletin 1101, Type A, Ventilated Speed Regulator, showing contact arm arrangement and resistance element.
It is only necessary to remove the cover and the regulator is ready for mounting.

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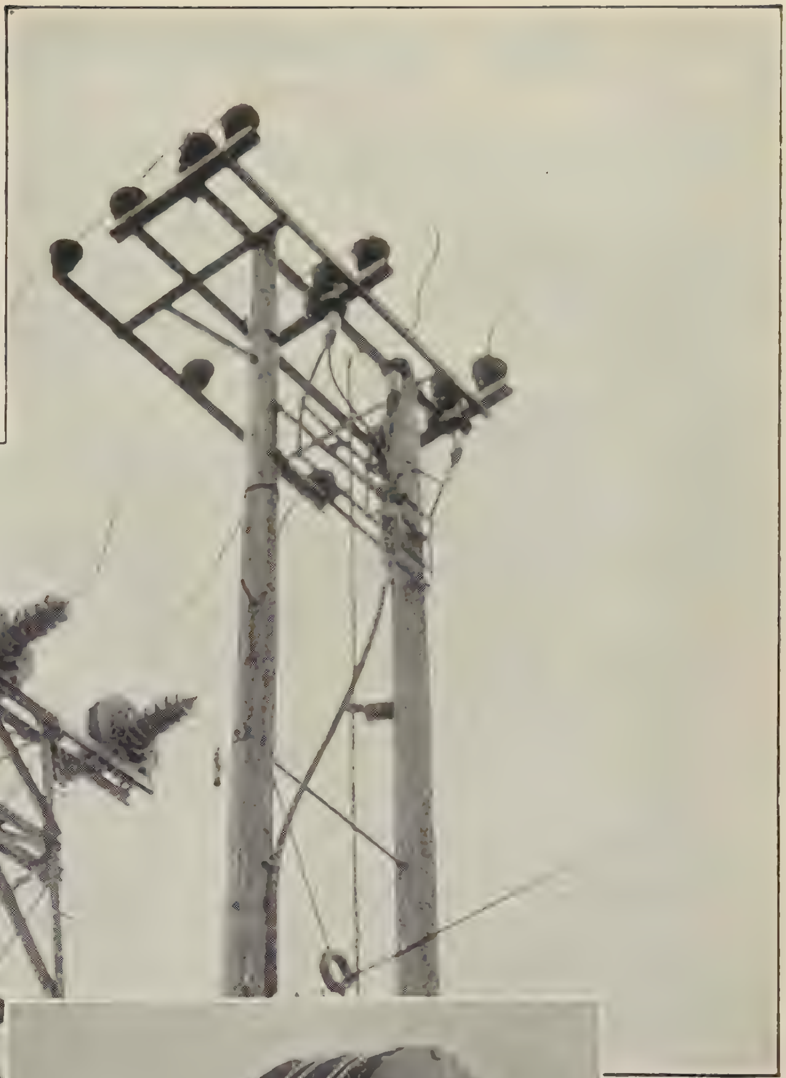

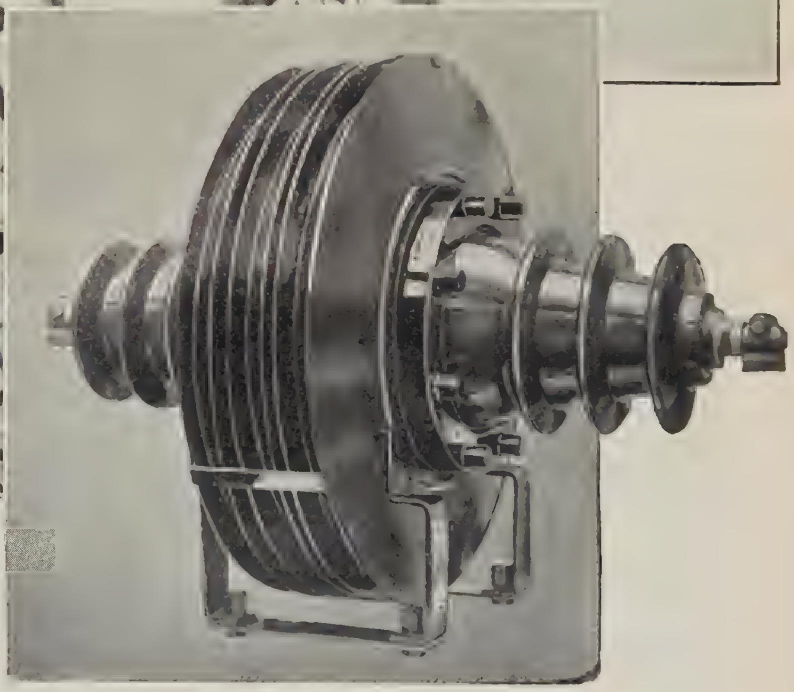

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